ATTACHMENT 1

ALCATEL LUCENT TEST REPORT

Global Product Compliance Laboratory
600-700 Mountain Avenue
Room 5B-108
Murray Hill, New Jersey 07974-0636 USA

LightSquared High Precision and Timing GPS Receiver Susceptibility Testing

Client

LightSquared

Product Evaluated

GPS HPT Receivers and GPS Antennas

Report Number

GPCL-2011-0158-LS

Date Issued:
December 22, 2011

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Revisions

Date	Revision	Section	Change

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1. System Information And Requirements

Device Under Test: (DUT) Various High Precision GPS Receivers from different vendors.

Measurement Procedure(s): ANSI C63.4 (2003)

Test Date(s): **November 21 – December 21, 2011**

Test Performed By:
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1.1 Introduction

The Device Under Test (DUT) are various GPS receivers that are used in High Precision GPS positioning and measurement applications such as agriculture, surveying and construction. Tests were conducted to determine the DUT's susceptibility to the proposed L-band LTE transmission signals of LightSquared Inc when tested with antennas with and without an integral band-pass filter circuit..

1.2 Purpose and Scope

The purpose of this document is to provide the test measurements and results, which were performed on the DUTs in accordance with the Precision and Timing Receiver LightSquared L-Band LTE, Test Plan version 1.4. The testing was done to check the performance of commercially available GPS devices that were tested with antennas that have been modified with a filter to prevent the LightSquared LTE signals from interfering with the operation of the GPS units. The test results for the modified antenna were compared to the test results of an unmodified antenna.

This document contains the following information:

- Description of the Equipment under Test (or apparatus) to which it refers.
- References to the test specification(s).
- Description of the test facilities and test environment.
- Applied test methodology
- Test configuration and performance criteria.

1.3 Executive Summary

The test results demonstrate that commercial GPS devices attached to a modified antenna did not show a degradation of C/No performance and other KPI's when subjected to a base station interference signal at a level of -15 dBm. The GPS devices connected to an unmodified antenna did show various degradations. When subjected to the handset interfering signals the GPS devices connected to the modified antennas showed no C/N performance degradation at -15 dBm. When the GPS devices were connected to an unmodified antenna, degradations were observed. In addition to the test plan, a worst case scenario of base station and handset, both at -15 dBm, at the device was performed. On the device tested with this condition with the modified antenna, no reduction in C/No was observed.

1.4 Reference Documents, Test Specifications & Procedures

Precision and Timing Receiver LightSquared L-Band LTE, Test Plan version 1.4.

1.5 Applicable Standards

A list of the applicable documents is provided herein:

- ANSI C63.4 (2003) entitled: "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz", American National Standards Institute, Institute of Electrical and Electronic Engineers, Inc., New York, NY 10017-2394, USA.

1.6 Tests Conducted

The DUT's were tested per the attached test descriptions. The results reported in this report are for the tracking, tracking sensitivity and acquisition tests. Due to time constraints, not all tests were performed on all of the DUTs.

1.7 Product Descriptions

The devices tested were High Precision GPS devices that are used in applications such as agriculture, surveying and construction, these GPS devices were supplied by LightSquared.. The antennas provided were JAVAD antennas which were unmodified or modified filter to prevent the LightSquared LTE frequencies from interfering with the GPS device operation.

The following are the products that were available to be tested.

	Manufacturer	**Model**
GPS Units	JAVAD	Triumph VI
	Topcon	NET-3GA
Antennas		
	Javad Modified	GrAnt-G3T
	Javad Unmodified	GrAnt-G3T

Test results are only being reported for the JAVAD and TOPCON GPS units in this version report.

12586 AND 17641 and 17169 GPS UNITS

1.8 Test Procedures

This is a general overview of the specified tests that were conducted. Not all tests were conducted at all test signal levels, timing of the application of interference signals and starting test levels were modified as needed to complete testing in allotted time. Complete and specific details can be found in the test plan.

There are three types of tests to be conducted they are as follows:

- Tracking
- Tracking Sensitivity
- Acquisition

1.8.1 Tracking Test Procedure

For each GPS device, the tracking tests were first executed with un-modified external antenna to establish the reference case and then with the modified antenna capable of rejecting LightSquared interference.

This test case was started after all receivers were tracking all GPS satellites for at least 1 minute.

For test configurations 1-3 an d9-11 of the LTE base station configurations specified in section 4.8.1 of the test plan, the following procedure was performed with the GPS simulator set up as the test plan.

1) Record the performance parameters for each DUT.
2) Set the LTE simulator for the selected configuration to an output power of -60 dBm (at the receivers).
    a) Record the performance parameters for each DUT.
    b) Increase the power of the LTE simulators output by 2 dB.
    c) Repeat steps 2a) and 2b) until the output power of the LTE simulators has reached -10 dBm at the device.
3) Dwell at MAX dBm for two minutes.
4) Set the LTE simulator the selected configuration to an output power of -10 dBm.
    a) Record the performance parameters.
    b) Decrease the power of the LTE simulator output by 1 dB.
    c) Repeat steps 4a) and 4b) until the LTE simulator power is set to MIN dBm.

1.8.2 Sensitivity Tracking Test Procedure

This test case was started after the receiver was tracking all GPS satellites for at least 1 minute.

For two configurations 1 and 6 from section 4.8.1 of the test plan the following procedures were performed with the GPS simulator set up for AGNS 24 Space Vehicles (SVs) Spec Constant Power

1) With LTE simulator power off collect 15 minutes of tracking performance parameters.
2) For each LTE power level from -35 dBm to -5 dBm in 5 dB steps:
    a) Set the power level of the simulators to the specified power.

b) Continuously record performance data during 2).

c) Reduce GPS simulator power at a rate of 5 dB/min.

d) Set the GPS simulator back to nominal signal level.

e) Turn the LTE simulator power off.

f) Wait 2 minutes to allow all DUTs to stabilize.

1.8.3 Acquisition Test Procedure

This test case was done from a "warm" start condition. The intent was that a normal acquisition processes be conducted between restarts, one that results from having ephemeris and position, but not precise GPS time (bit sync unknown).

For two configurations 1 and 6 from section 4.8.1 of the test plan the following procedures were performed with the GPS simulator set up for AGNS 24 SVs Spec Constant Power

1) Power on device and record performance data for 5 minutes.
2) For each LTE power level from -30 dBm to -15 dBm in 10 dB steps:
   a) Record performance data for 15 minutes.
   b) During each 15 minute test, force restart of the receiver at least every 3 minutes. A minimum of 4 restarts should be initiated at each power level.

1.9 Calibration and Setup Procedures

1.9.1 GPS Simulator Transmit Level

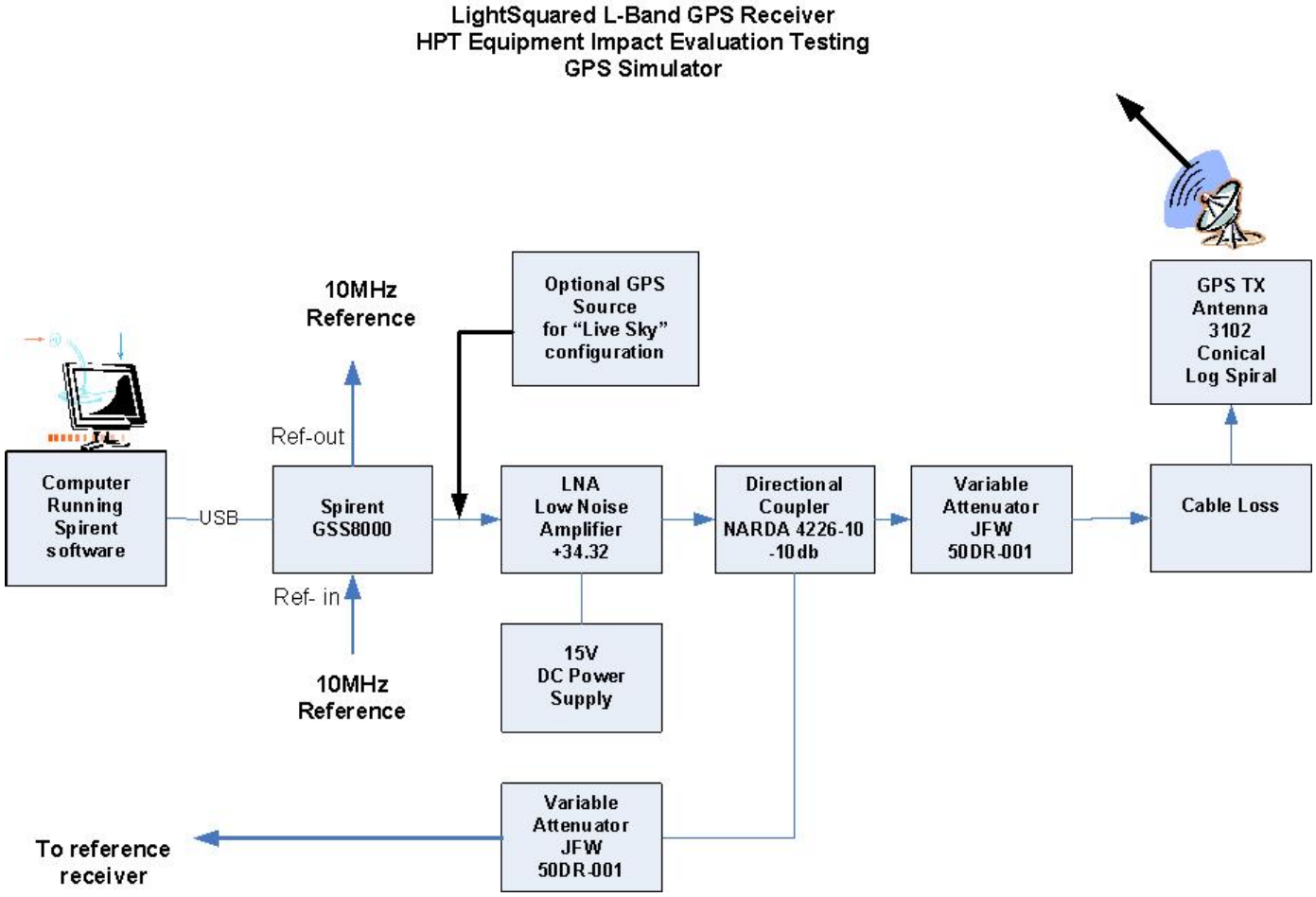
The output level of the Spirent GNSS simulator was adjusted to obtain a C/No value of 47 for the device under test, this is calculated to be approximately -130 dBm at the device.

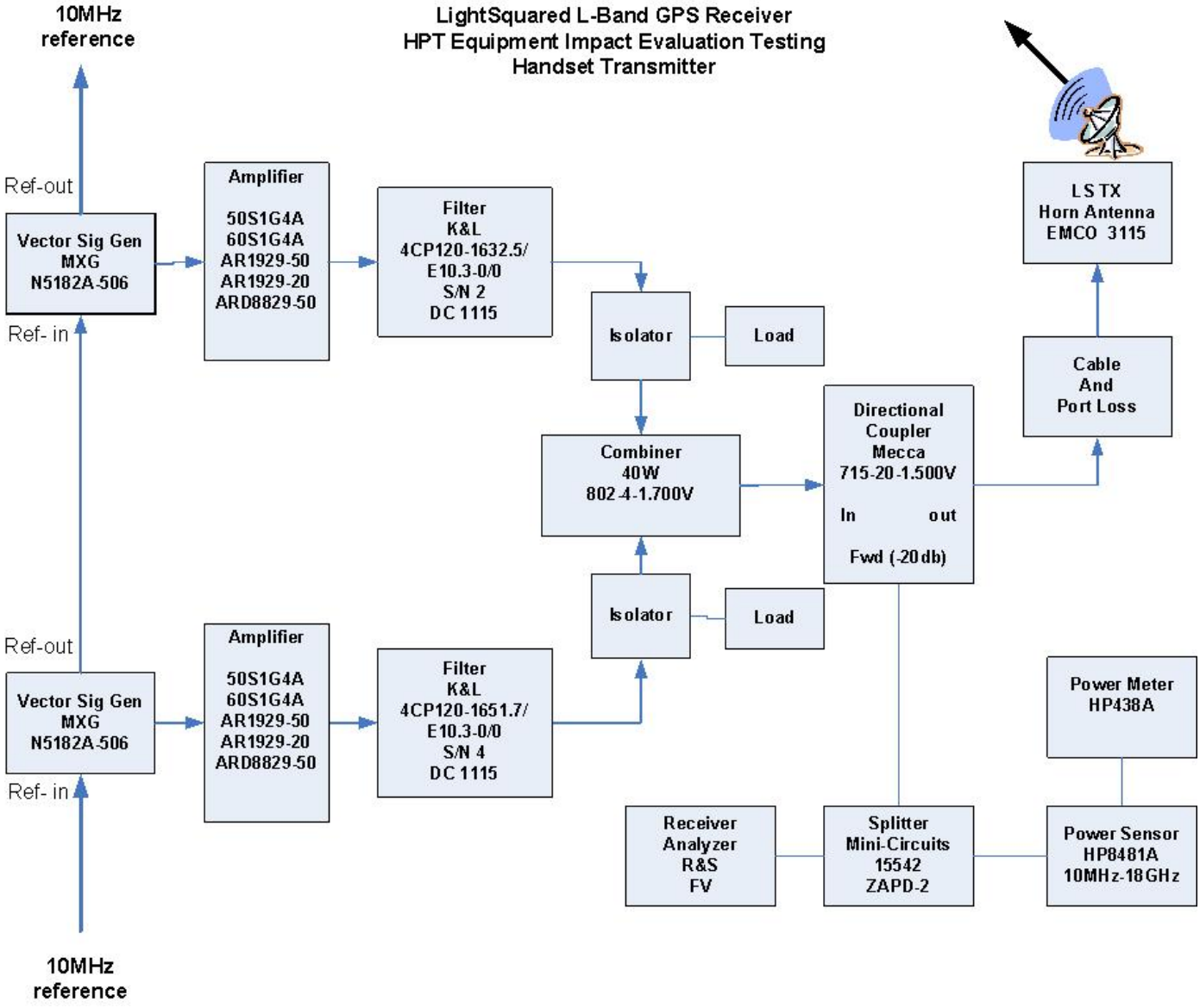
1.9.2 Live Sky Calibration Procedure

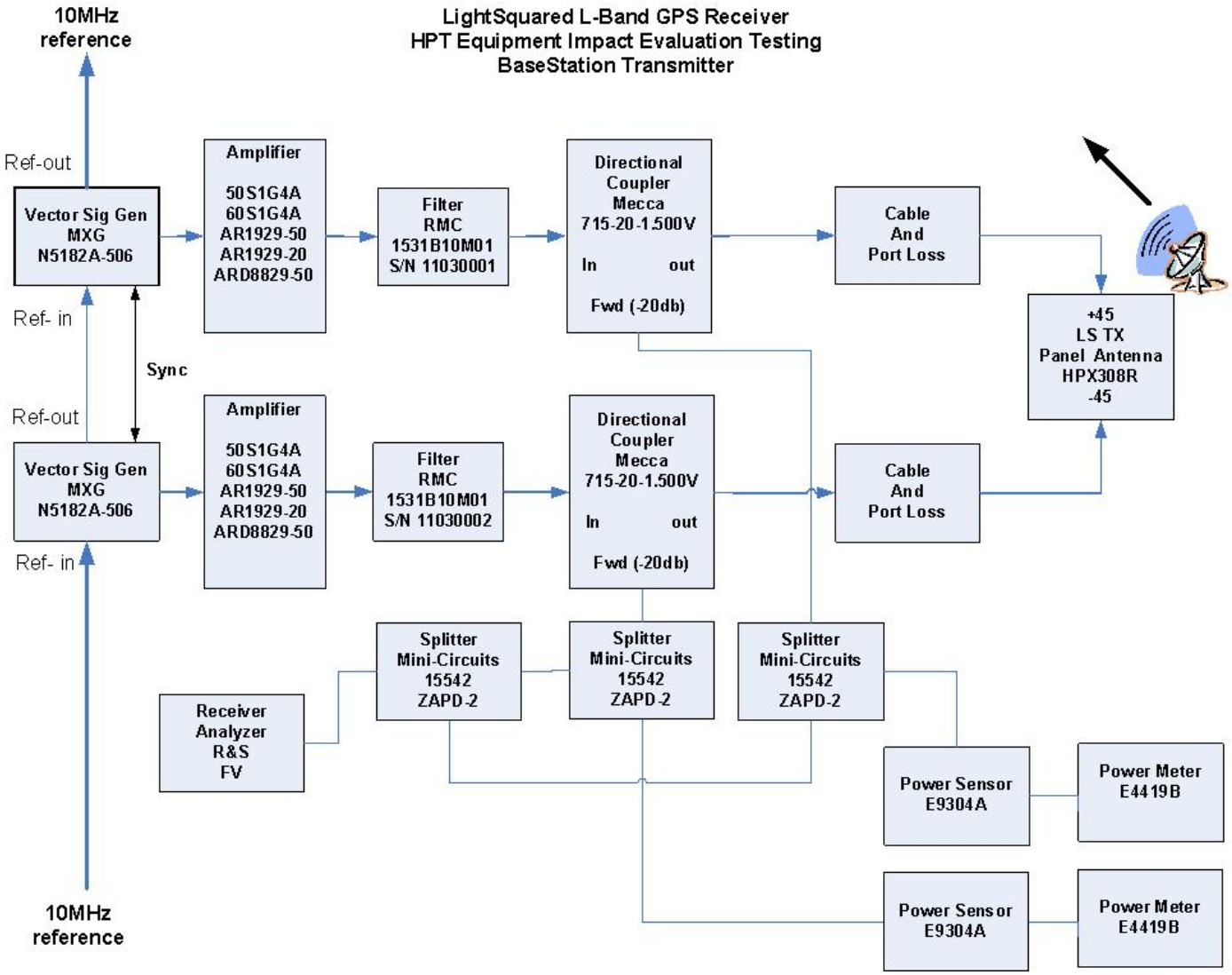
1. The reference antenna stand was setup outside the building with a southern exposure. If available, the unmodified antenna was used as the reference antenna.
2. The portable GPS receiver was connected through a short cable to the reference antenna and the C/No values were documented.
3. The reference antenna was then connected to the GPS environment simulator.
4. The DUT was then connected to the antenna under test in the chamber.
5. The GPS environment simulator was then adjusted to obtain the same GPS C/No values as in step 2.
6. The DUT was then tested per the desired test (tracking, reacquisition, etc) procedures.

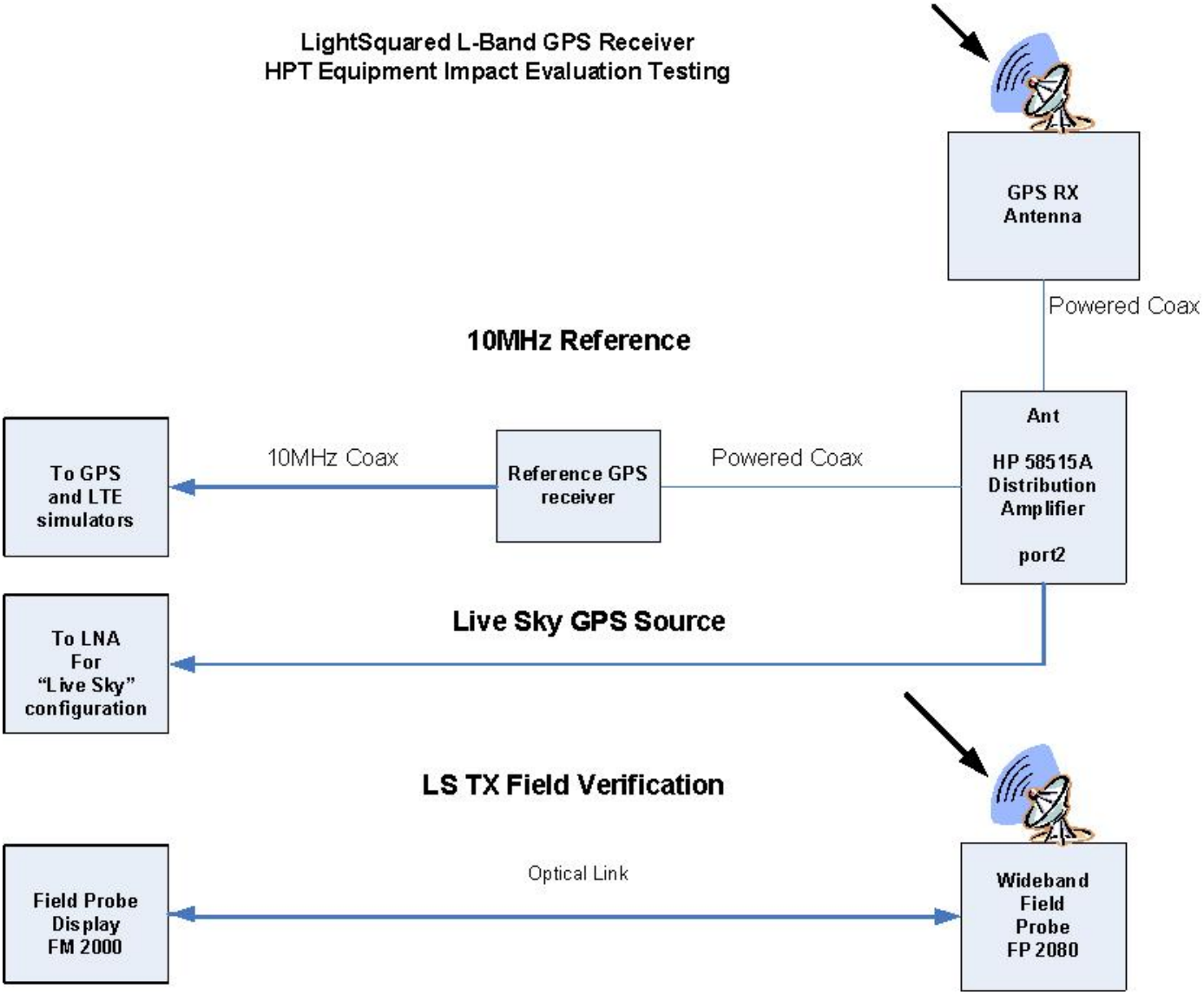
1.10 Test Configuration

1.10.1 Electrical Configuration



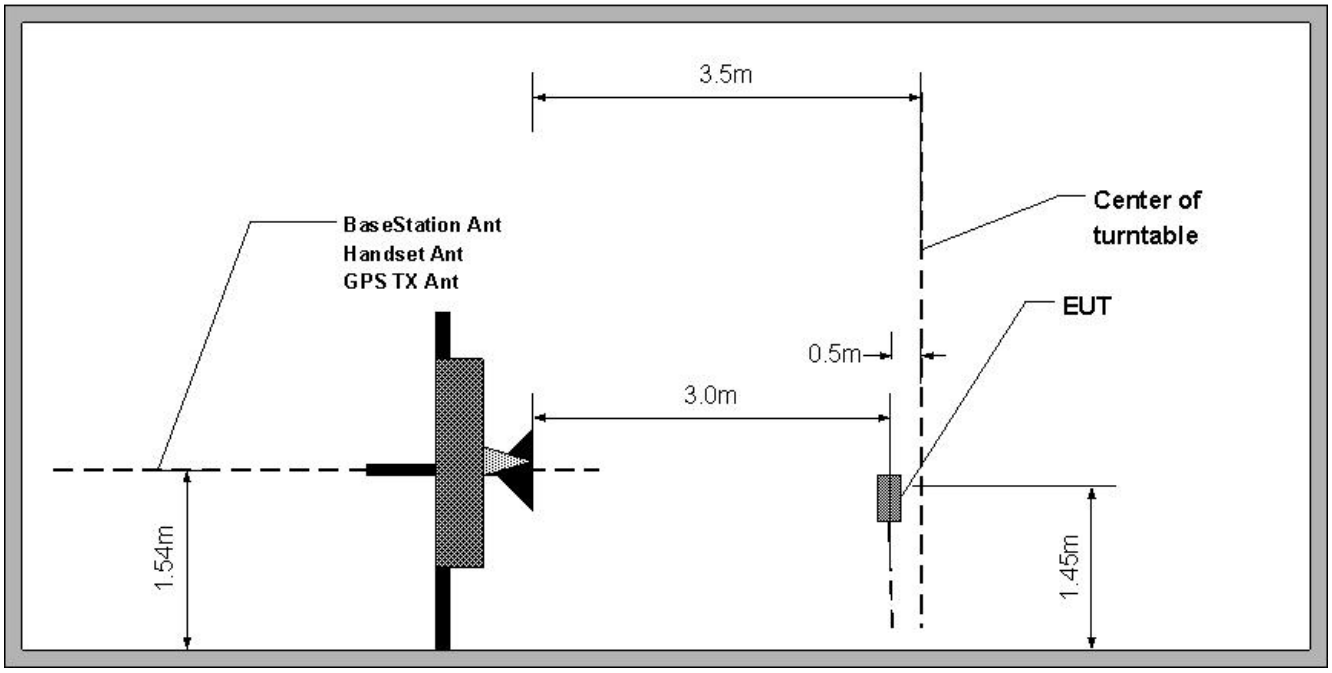

LightSquared L-Band GPS Receiver
HPT Equipment Impact Evaluation Testing
Handset Transmitter
10MHz reference
Ref-out
Vector Sig Gen MXG N5182A-506
Ref- in
Amplifier 50S1G4A 60S1G4A AR1929-50 AR1929-20 ARD8829-50
Filter K&L 4CP120-1632.5/ E10.3-0/0 S/N 2 DC 1115
Isolator
Load
Combiner 40W 802-4-1.700V
Directional Coupler Mecca 715-20-1.500V In out Fwd (-20db)
Cable And Port Loss
LS TX Horn Antenna EMCO 3115
Ref-out
Vector Sig Gen MXG N5182A-506
Ref- in
Amplifier 50S1G4A 60S1G4A AR1929-50 AR1929-20 ARD8829-50
Filter K&L 4CP120-1651.7/ E10.3-0/0 S/N 4 DC 1115
Isolator
Load
Power Meter HP438A
Receiver Analyzer R&S FV
Splitter Mini-Circuits 15542 ZAPD-2
Power Sensor HP8481A 10MHz-18GHz
10MHz reference


10MHz reference
LightSquared L-Band GPS Receiver
HPT Equipment Impact Evaluation Testing
BaseStation Transmitter
Ref-out
Vector Sig Gen MXG N5182A-506
Ref- in
Sync
Ref-out
Vector Sig Gen MXG N5182A-506
Ref- in
10MHz reference
Amplifier 50S1G4A 60S1G4A AR1929-50 AR1929-20 ARD8829-50
Amplifier 50S1G4A 60S1G4A AR1929-50 AR1929-20 ARD8829-50
Filter RMC 1531B10M01 S/N 11030001
Filter RMC 1531B10M01 S/N 11030002
Directional Coupler Mecca 715-20-1.500V In out Fwd (-20db)
Directional Coupler Mecca 715-20-1.500V In out Fwd (-20db)
Cable And Port Loss
Cable And Port Loss
+45 LS TX Panel Antenna HPX308R -45
Splitter Mini-Circuits 15542 ZAPD-2
Splitter Mini-Circuits 15542 ZAPD-2
Splitter Mini-Circuits 15542 ZAPD-2
Receiver Analyzer R&S FV
Power Sensor E9304A
Power Meter E4419B
Power Sensor E9304A
Power Meter E4419B

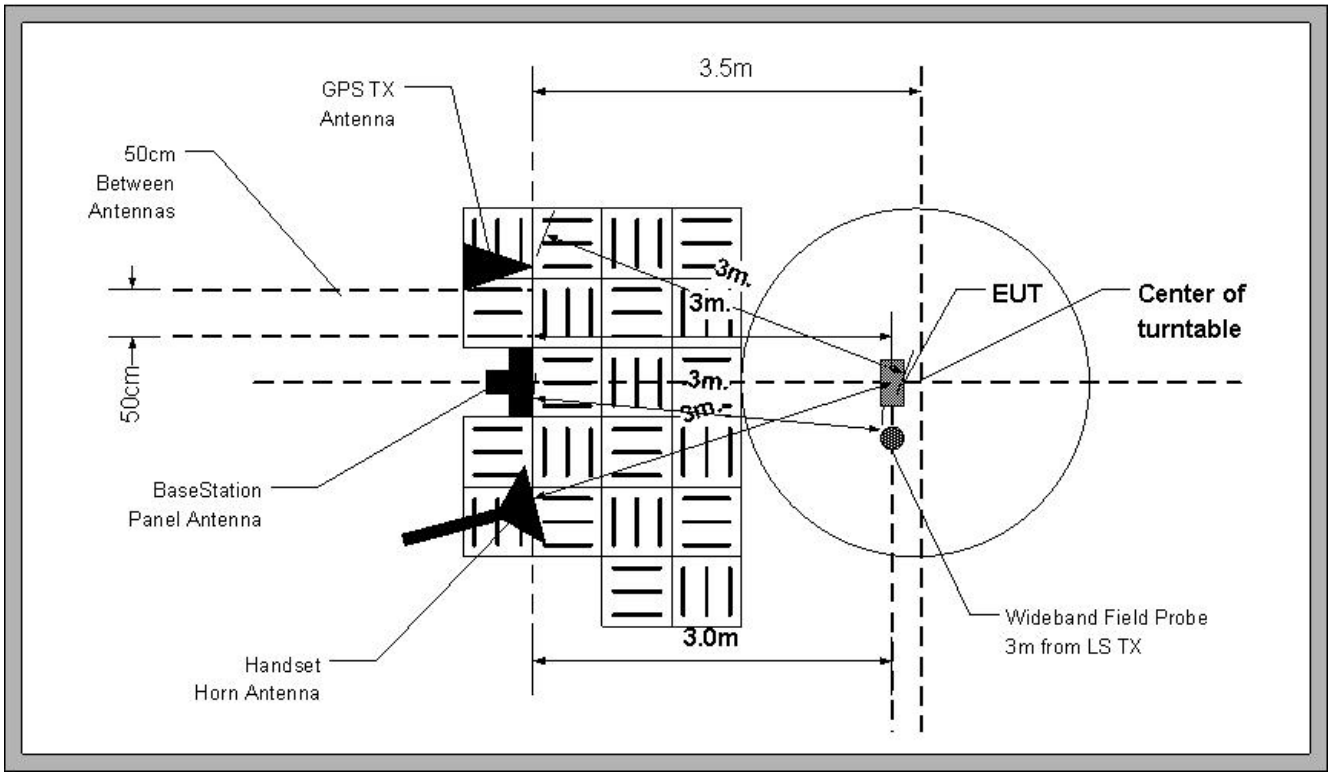

LightSquared L-Band GPS Receiver
HPT Equipment Impact Evaluation Testing
GPS RX Antenna
Powered Coax
10MHz Reference
Ant
HP 58515A Distribution Amplifier
port2
To GPS and LTE simulators
10MHz Coax
Reference GPS receiver
Powered Coax
To LNA For "Live Sky" configuration
Live Sky GPS Source
LS TX Field Verification
Optical Link
Field Probe Display FM 2000
Wideband Field Probe FP 2080

1.10.2 Physical Configuration

Physical Test Configuration in AR4 (Side View)



Physical Test Configuration in AR4 (Top View)



1.11 Test Facilities

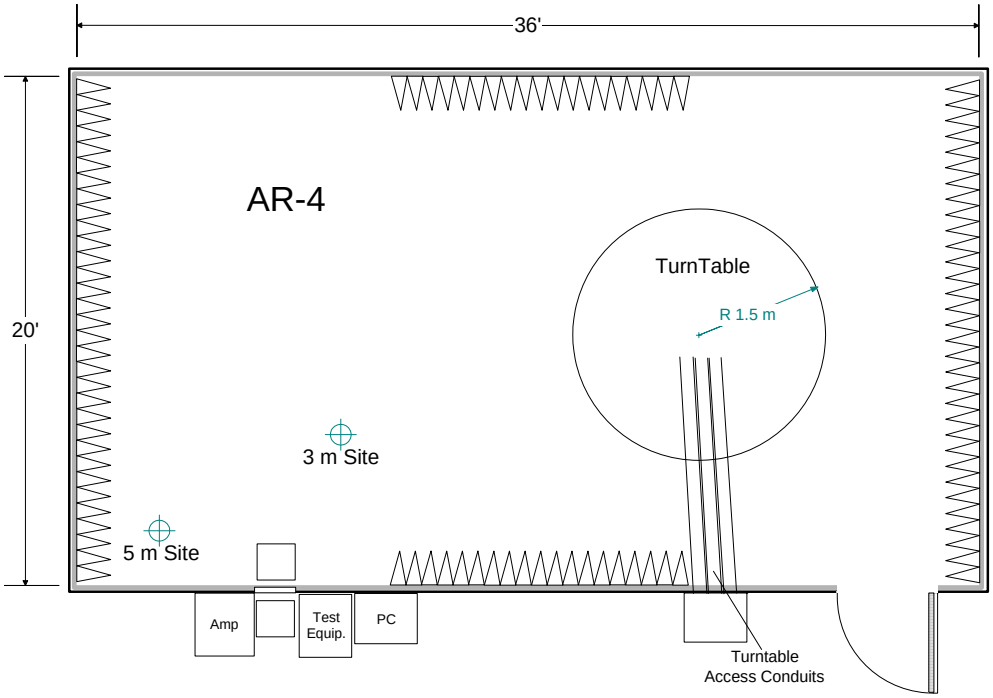
Murray Hill AR-4

The AR-4 chamber is a Panashield 3/5 meter compliance chamber. This chamber is a self supporting modular RF shielding design with nominal dimensions of 6.3m W x 11.1m L x 5.4m H. The walls and ceiling are treated with FFG-1000 & FFG-2000 TOYO grid ferrite treatment. In the specular regions HY-35 hybrid absorber is mounted on ferrite. A removable FFG-1000 ferrite tile grid 3.6m W x 3.3m D is placed between the EUT and antenna during radiated immunity testing. In addition, TDK ICM-006 absorber are installed for 1 to 18 GHz mid range performance. The operational frequency range of the chamber is 30 MHz to 18 GHz. The chamber is single point grounded to a ground rod/ground array.

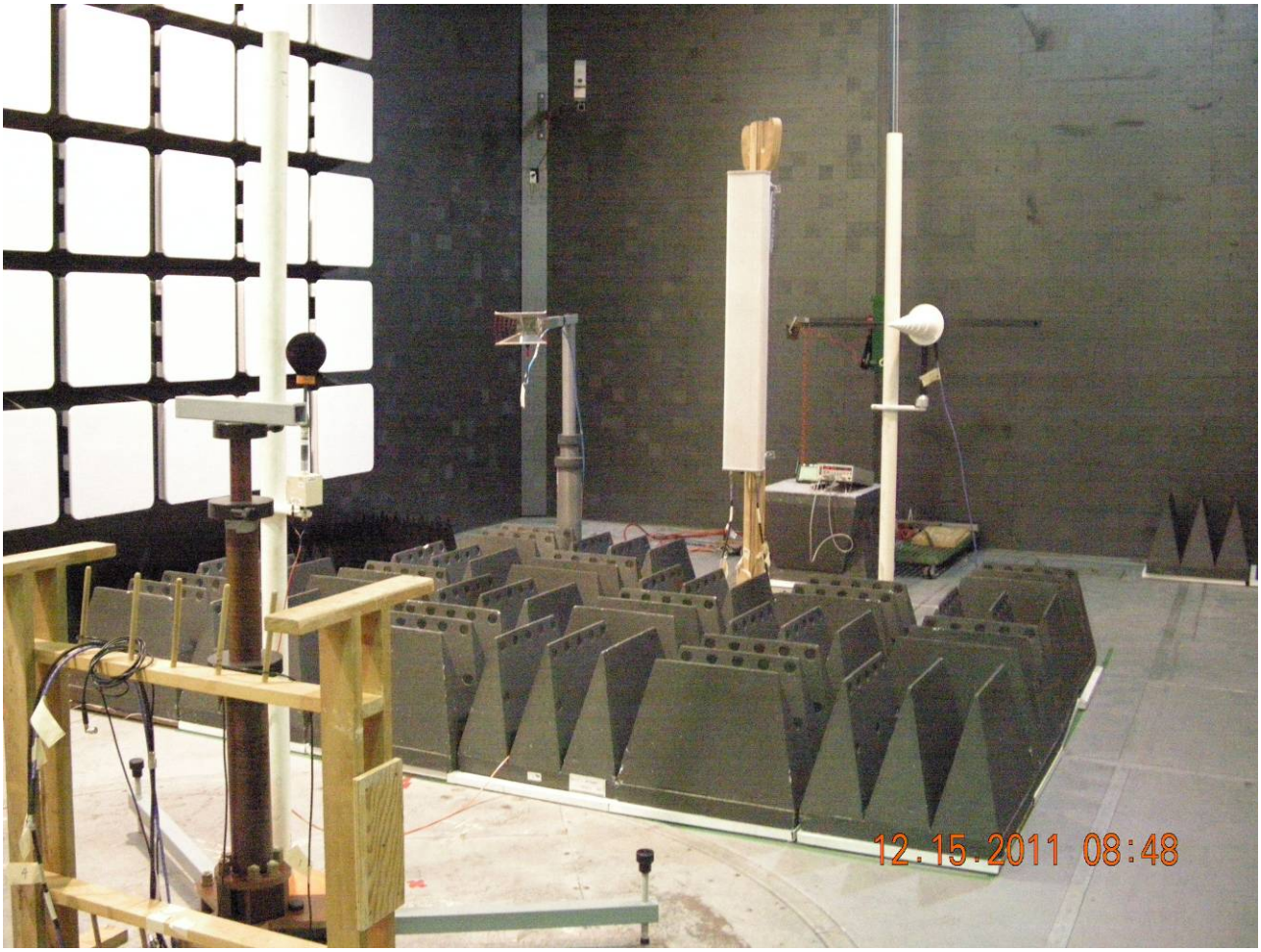
Access to the chamber is provided with a 1.2m W x 2.4m H RCM auto-latch door. The chamber is provided with a 3 meter variable speed 8800 LB capacity turntable, and a 4 meter antenna mast. Measurement distances of 3 and 5 meters can be achieved with an antenna search height of 4 meters. RF Line Filters are installed on the on the power input lines to remove RF ambient signals. These filters are encased in shielded electrical enclosures. Access from outside the chamber to the center hub of the turntable is provided via 3 6" metallic conduits. The turntable is positioned so that an EUT will have a minimum setback distance of 1 meter from the side walls and ceiling during testing.

The chamber is outfitted with three recessed access boxes. From these boxes RF cables are run under the raised flooring to a bulkhead feed-thru panel and out to a breakout panel adjacent to the test instrumentation. The raised flooring inside the chamber is constructed with modular shielding panels interconnected in the same fashion as the chamber walls. 1/8" galvanized steel plates are used between the batten strips to flush out the flooring. The chamber lighting and wall treatments are specifically designed to provide an office like work environment inside the chamber. A closed circuit color CCTV system shielded to 200 V/m is installed to allow monitoring of the EUT. A dedicated HVAC system with humidity control provides a constant temperature and humidity inside the chamber.

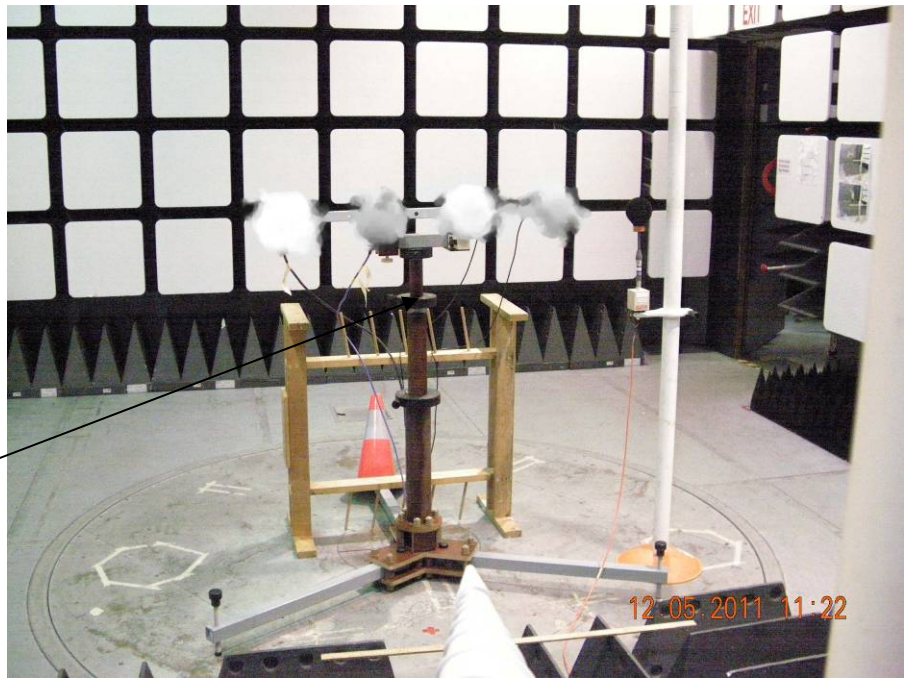
All power entering the chamber is filtered. The filters provide 100 dB insertion loss from 10 kHz to 10 GHz IAW with MIL-STD-220A. Dedicated power is provided in the center hub of the turntable for the EUT's.

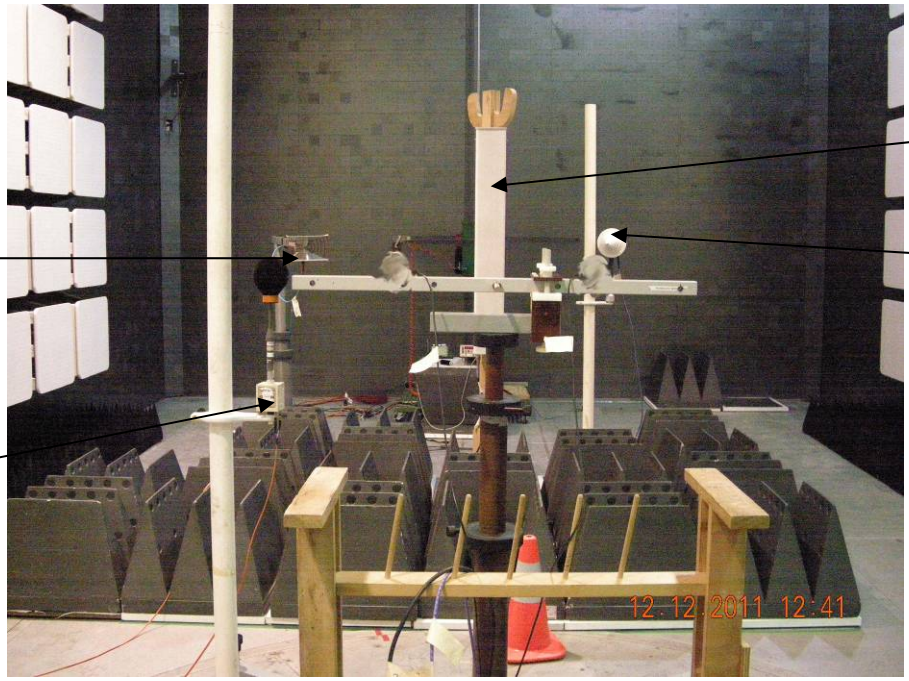


1.11.1 Pictures of Test Facilities



Alcatel-Lucent
AR-4





AR-4 GPS Test Setup

Live Sky Antenna Setup

1.12 Equipment Lists

Murray Hill Equipment List

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer 10HZ-3.6GHZ	101993	Rohde & Schwarz	FSV3	4/6/2011	4/27/2012
Spectrum Analyzer 10HZ-3.6GHZ	101994	Rohde & Schwarz	FSV3	4/7/2011	9/7/2012
MXG Vector Signal Generator	MY50140028	Agilent	N5182A	4/18/2010	4/29/2012
MXG Vector Signal Generator	MY50142654	Agilent	N5182A	10/22/2011	11/15/2014
MXG Vector Signal Generator	MY47420542	Agilent	N5182A	11/15/2011	11/15/2014
MXG Vector Signal Generator	MY50140842	Agilent	N5182A	11/1/2011	11/15/2014
Band Pass Filter	11030001	LightSquared	1531B10M01	NA	NA
Band Pass Filter	11030002	LightSquared	1531B10M01	NA	NA
Band Pass Filter	2	K&L	4CP120-1632.5	NA	NA
Band Pass Filter	4	K&L	4CP120-1651.7	NA	NA
Multiclass satellite simulator	8792	Spirent	GSS8000	NA	NA
30 Amplifier 0.8 – 3.0 GHz 50 Watts	30752	Amplifier Research	30S1G3M3	NA	NA
25 Watt Amplfier	21071	Amplifier Research	25S1G4	NA	NA
50 Watt Amplifier	N1C5A00-1039	Comtech-PST	ARD 8829-50	NA	NA
20 Watt Amplifier	M3D7A00-114	Comtech	ARD 1929-20	NA	NA
Power Meter	3513U03984	Hewlett Packard	438A	4/13/2011	4/13/2012
Power Meter	3513U04024	Hewlett-Packard	438A	8/18/2011	8/18/2012
Power Meter	GB42420582	Agilent	E4419B	3/11/2010	3/11/2012
Power Meter	GB39513585	Agilent	E4419B	5/25/2010	6/17/2012
Power Sensor	US37290578	Hewlett Packard	8481A	2/24/2011	2/24/2012
Power Sensor 10 MHz-18 GHz	2702A81114	Agilent	8481A	3/29/2011	3/29/2012
6GHz Power sensor	MY51070079	Agilent	E9304A	2/23/2011	4/18/2012
6GHz Power sensor	MY41496465	Agilent	E9304A	10/6/2011	11/15/2012
Isotropic Field Monitor	23282	Amplifier Research	FM 2000	NA	NA
Isotropic Field Probe 80 MHz-40 GHz	28124	Amplifier Research	FP 2080	4/7/2011	4/7/2012
Amplifier	NA	Alcatel-Lucent	1-2GHz Amp	NA	NA
Spiral Antenna	00128329	ETS-Lindgren	3102L	11/19/2010	5/19/2012
Double Ridged Horn Antenna 1-18GHz	9006-3460	EMCO	3115	1/12/2011	1/12/2012
Antenna – Single Band Panel, Dual Polarization 1525-1710 MHz	67570033 FE110901738	Argus	HPX308R HPX308R/T-115GL	NA	NA
Temperature and Humidity Gauge	CH06464	Extech	RH520	7/20/2011	7/20/2012

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
30dB Attenuator	BB0447	Weinschel	47-3043	NA	NA
Attenuator	271294	JFW Industries	50DR-001	NA	NA
Attenuator	399511	JFW Industries	50DR-001	NA	NA
Directional Coupler	02828	Narda	4226-10	NA	NA
10 MHz Source	5650516	Feizar, Inc	GPStar 565-201-501	NA	NA
GPS Distribution	3731	Hewlett Packard	5815A	NA	NA
Power Supply	KR61313976	Hewlett Packard	E3610A	NA	NA
Power Supply	KR40606846	Hewlett Packard	E3611A	NA	NA

1.13 Test Bed Calibration and Measurement Calculations

1.13.1 DownLink

	Bell Labs LightSquared HPT - GPS Test Bed Calibration - BaseStation								CM/NPA	17-Nov-11
		Maximum LightSquared TX Power:		62	dBm EIRP		(downlink)			
		Test Antenna Separation:		3	Meter					
		Antenna Front-Back Isolation:		30	dB					
		Radiating Antenna Gain:		14.8	dBi					
		Free space loss frequency:		1531	MHz					
		Test Bed Power Meter Offset:		20	dB					
							Equivalent	Equivalent	Equivalent	
	Raw	LTE TX	LTE TX	Propgation	Power	Power	Boresight	Boresight	off-lobe	
	Pwr Mtr	Power	EIRP	Loss	at device	diff	Distance	Distance	Distance	LTE Tx
Notes	dBm	dBm	dBi	dB	dBm	dB	Meters	Feet	Meters	W
1	-25.0	-5	9.8	45.6	-35.8	97.8	1222	4009	38.6	3.16E-04
	-24.0	-4	10.8	45.6	-34.8	96.8	1089	3573	34.4	3.98E-04
	-23.0	-3	11.8	45.6	-33.8	95.8	971	3184	30.7	5.01E-04
	-22.0	-2	12.8	45.6	-32.8	94.8	865	2838	27.4	6.31E-04
	-21.0	-1	13.8	45.6	-31.8	93.8	771	2529	24.4	7.94E-04
	-20.0	0	14.8	45.6	-30.8	92.8	687	2254	21.7	1.00E-03
	-19.0	1	15.8	45.6	-29.8	91.8	613	2009	19.4	1.26E-03
	-18.0	2	16.8	45.6	-28.8	90.8	546	1791	17.3	1.58E-03
	-17.0	3	17.8	45.6	-27.8	89.8	487	1596	15.4	2.00E-03
	-16.0	4	18.8	45.6	-26.8	88.8	434	1422	13.7	2.51E-03
	-15.0	5	19.8	45.6	-25.8	87.8	386	1268	12.2	3.16E-03
	-14.0	6	20.8	45.6	-24.8	86.8	344	1130	10.9	3.98E-03
	-13.0	7	21.8	45.6	-23.8	85.8	307	1007	9.7	5.01E-03
	-12.0	8	22.8	45.6	-22.8	84.8	274	897	8.7	6.31E-03
	-11.0	9	23.8	45.6	-21.8	83.8	244	800	7.7	7.94E-03
	-10.0	10	24.8	45.6	-20.8	82.8	217	713	6.9	1.00E-02
	-9.0	11	25.8	45.6	-19.8	81.8	194	635	6.1	1.26E-02
	-8.0	12	26.8	45.6	-18.8	80.8	173	566	5.5	1.58E-02
	-7.0	13	27.8	45.6	-17.8	79.8	154	505	4.9	2.00E-02
	-6.0	14	28.8	45.6	-16.8	78.8	137	450	4.3	2.51E-02
	-5.0	15	29.8	45.6	-15.8	77.8	122	401	3.9	3.16E-02
	-4.0	16	30.8	45.6	-14.8	76.8	109	357	3.4	3.98E-02
	-3.0	17	31.8	45.6	-13.8	75.8	97	318	3.1	5.01E-02
	-2.0	18	32.8	45.6	-12.8	74.8	87	284	2.7	6.31E-02
	-1.0	19	33.8	45.6	-11.8	73.8	77	253	2.4	7.94E-02
	0.0	20	34.8	45.6	-10.8	72.8	69	225	2.2	1.00E-01
	1.0	21	35.8	45.6	-9.8	71.8	61	201	1.9	1.26E-01
	2.0	22	36.8	45.6	-8.8	70.8	55	179	1.7	1.58E-01
	3.0	23	37.8	45.6	-7.8	69.8	49	160	1.5	2.00E-01
	4.0	24	38.8	45.6	-6.8	68.8	43	142	1.4	2.51E-01
	5.0	25	39.8	45.6	-5.8	67.8	39	127	1.2	3.16E-01
	6.0	26	40.8	45.6	-4.8	66.8	34	113	1.1	3.98E-01
	7.0	27	41.8	45.6	-3.8	65.8	31	101	1.0	5.01E-01
	8.0	28	42.8	45.6	-2.8	64.8	27	90	0.9	6.31E-01
	9.0	29	43.8	45.6	-1.8	63.8	24	80	0.8	7.94E-01
	10.0	30	44.8	45.6	-0.8	62.8	22	71	0.7	1.00E+00
	11.0	31	45.8	45.6	0.2	61.8	19	64	0.6	1.26E+00
	12.0	32	46.8	45.6	1.2	60.8	17	57	0.5	1.58E+00
	13.0	33	47.8	45.6	2.2	59.8	15	50	0.5	2.00E+00
	14.0	34	48.8	45.6	3.2	58.8	14	45	0.4	2.51E+00
	15.0	35	49.8	45.6	4.2	57.8	12	40	0.4	3.16E+00
	16.0	36	50.8	45.6	5.2	56.8	11	36	0.3	3.98E+00
	17.0	37	51.8	45.6	6.2	55.8	10	32	0.3	5.01E+00
	18.0	38	52.8	45.6	7.2	54.8	9	28	0.3	6.31E+00
	19.0	39	53.8	45.6	8.2	53.8	8	25	0.2	7.94E+00
2	20.0	40	54.8	45.6	9.2	52.8	7	23	0.2	1.00E+01
	Notes:	1	Estimated Minimum RF Test Bed Power, equiv. to > 2.4 km to antenna boresight							
		2	Estimated Maximum RF Test Bed Power, equiv. to < 15 m to antenna boresight							

1.13.2 UpLink

Bell Labs LightSquared GPS Test Bed Calibration - Handset							CM/NPA	13-May-11
	Maximum LightSquared TX Power:		23	dBm EIRP			(uplink)	
	Test Antenna Separation:		3	Meter				
	Antenna Front-Back Isolation:		n/a	dB				
	Radiating Antenna Gain:		8.8	dBi				
	Free space loss frequency:		1632.5	MHz				
	Test Bed Power Meter Offset:		20	dB				
Raw	LTE TX	LTE TX	Propgation	Power	Power	Equivalent	Equivalent	
Pwr Mtr	Power	EIRP	Loss	at device	diff	Distance	Distance	LTE Tx
dBm	dBm	dBi	dB	dBm	dB	Meters	Feet	W
-25	-5	3.8	46.2	-42.4	65.4	27	90	3.16E-04
-24	-4	4.8	46.2	-41.4	64.4	24	80	3.98E-04
-23	-3	5.8	46.2	-40.4	63.4	22	71	5.01E-04
-22	-2	6.8	46.2	-39.4	62.4	19	64	6.31E-04
-21	-1	7.8	46.2	-38.4	61.4	17	57	7.94E-04
-20	0	8.8	46.2	-37.4	60.4	15	50	1.00E-03
-19	1	9.8	46.2	-36.4	59.4	14	45	1.26E-03
-18	2	10.8	46.2	-35.4	58.4	12	40	1.58E-03
-17	3	11.8	46.2	-34.4	57.4	11	36	2.00E-03
-16	4	12.8	46.2	-33.4	56.4	10	32	2.51E-03
-15	5	13.8	46.2	-32.4	55.4	9	28	3.16E-03
-14	6	14.8	46.2	-31.4	54.4	8	25	3.98E-03
-13	7	15.8	46.2	-30.4	53.4	7	23	5.01E-03
-12	8	16.8	46.2	-29.4	52.4	6	20	6.31E-03
-11	9	17.8	46.2	-28.4	51.4	5.5	18	7.94E-03
-10	10	18.8	46.2	-27.4	50.4	4.9	16	1.00E-02
-9	11	19.8	46.2	-26.4	49.4	4.3	14	1.26E-02
-8	12	20.8	46.2	-25.4	48.4	3.9	13	1.58E-02
-7	13	21.8	46.2	-24.4	47.4	3.4	11	2.00E-02
-6	14	22.8	46.2	-23.4	46.4	3.1	10	2.51E-02
-5	15	23.8	46.2	-22.4	45.4	2.7	9.0	3.16E-02
-4	16	24.8	46.2	-21.4	44.4	2.4	8.0	3.98E-02
-3	17	25.8	46.2	-20.4	43.4	2.2	7.1	5.01E-02
-2	18	26.8	46.2	-19.4	42.4	1.9	6.4	6.31E-02
-1	19	27.8	46.2	-18.4	41.4	1.7	5.7	7.94E-02
0	20	28.8	46.2	-17.4	40.4	1.5	5.0	1.00E-01
1	21	29.8	46.2	-16.4	39.4	1.4	4.5	1.26E-01
2	22	30.8	46.2	-15.4	38.4	1.2	4.0	1.58E-01
3	23	31.8	46.2	-14.4	37.4	1.1	3.6	2.00E-01
4	24	32.8	46.2	-13.4	36.4	1.0	3.2	2.51E-01
5	25	33.8	46.2	-12.4	35.4	0.9	2.8	3.16E-01
6	26	34.8	46.2	-11.4	34.4	0.8	2.5	3.98E-01
7	27	35.8	46.2	-10.4	33.4	0.7	2.3	5.01E-01
8	28	36.8	46.2	-9.4	32.4	0.6	2.0	6.31E-01
9	29	37.8	46.2	-8.4	31.4	0.55	1.8	7.94E-01
10	30	38.8	46.2	-7.4	30.4	0.49	1.6	1.00E+00
11	31	39.8	46.2	-6.4	29.4	0.43	1.4	1.26E+00
12	32	40.8	46.2	-5.4	28.4	0.39	1.3	1.58E+00
13	33	41.8	46.2	-4.4	27.4	0.34	1.1	2.00E+00
14	34	42.8	46.2	-3.4	26.4	0.31	1.0	2.51E+00
15	35	43.8	46.2	-2.4	25.4	0.27	0.9	3.16E+00
16	36	44.8	46.2	-1.4	24.4	0.24	0.8	3.98E+00
17	37	45.8	46.2	-0.4	23.4	0.22	0.7	5.01E+00
18	38	46.8	46.2	0.6	22.4	0.19	0.6	6.31E+00
19	39	47.8	46.2	1.6	21.4	0.17	0.6	7.94E+00
20	40	48.8	46.2	2.6	20.4	0.15	0.50	1.00E+01
Notes:	1	Estimated Minimum RF Test Bed Power, equiv. to 90 ft to LTE mobile						
	2	Estimated Maximum RF Test Bed Power, equiv. to 6 inches to LTE mobile						

2. TEST DATA

Attachment A – Table of Tests Performed
Attachment B – Base Station Tracking with simulated signal
Attachment C – Handset Tracking
Attachment D – Base Station – Handset Signals Combined Tracking
Attachment E – Base Station Tracking with live signal
Attachment F – Acquisition
Attachment G – Sensitivity

ATTACHMENT A
(Table of Tests Performed and Test Summary)

1. Checkmark indicates the test was performed.
2. Information in the cells indicates the signal levels tests and the steps between each signal level tested.

DUT	Configurations 1-3 Simulated Live Sky 1) Base Station only 2) Handset only 3) BaseStation & Handset 4-6Live Sky 9) Base Station only 10) Handset only 11) BaseStation & Handset	Tracking -85dbm to -15dbm Ramp Up/Down Step 1dbm Configurations 0-3, 5-7, 9-11	Tracking Sensitivity -85dbm to -15dbm Step 5db Step 1db Dwell 1min Configurations 1,6	Acquisition "warm" start -85dbm to -15dbm Step 10db Restart every 3 min Configurations 1,6
12586 – with Modifed Antenna	1	✓ 2dbm step -35dbm to -19dbm And back to -35dBm	✓ Interference -30dbm, -24dbm, GPS Level -130dbm to -145dbm	✓ Step 6,4,5db -30dbm to -15dbm
17169 with Unmodified Antenna	1	✓ 5dbm step -35dbm to -19dbm	✓ Interference -30dbm, -24dbm, -15dbm GPS Level -130dbm to -150dbm	✓ Step 6,4,6db -30dbm to -14dbm
17641 with Unmodified Antenna	1	✓ 2dbm step -35dbm to -10dbm	✓ Interference -30dbm, -24dbm, -15dbm GPS Level -130dbm to -155dbm	✓ Step 6,4,6db -30dbm to -14dbm
17169 with Modifed Antenna	1	✓ 2dbm step -35dbm to -10dbm	✓ Interference -30dbm, -24dbm, -15dbm GPS Level -130dbm to -155dbm	✓ Step 6,4,5db -30dbm to -15dbm

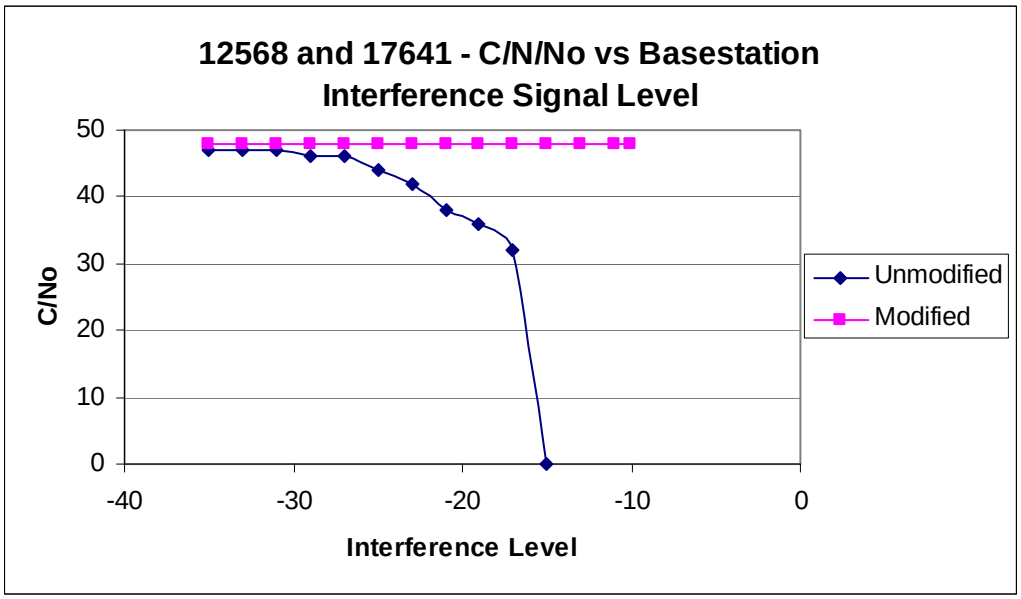
12586 – with Modifed Antenna	2	✓ 2 dBm Steps -37 to -15 and then returned to -37 dBm		
17641 – with Umodifed Antenna	2	✓ 2 dBm Steps -37 to -15 and then returned to -37 dBm		
12586 – with Modifed Antenna	3	✓ 2 dBm Steps -40 to -22 and then returned to -36 dBm		
17169 with Unmodified Antenna	2	✓ 2 dBm Steps -40 to -22 and then returned to -36 dBm		
17169 with modified Antenna	2	✓ 2 dBm Steps -40 to -22 and then returned to -36 dBm		
17169 with Unmodified Antenna	3	✓ 2 dBm Steps -47 to -27 and then returned to -36 dBm		
17169 with modified Antenna	3	✓ 2 dBm Steps -47, -15 and -10		

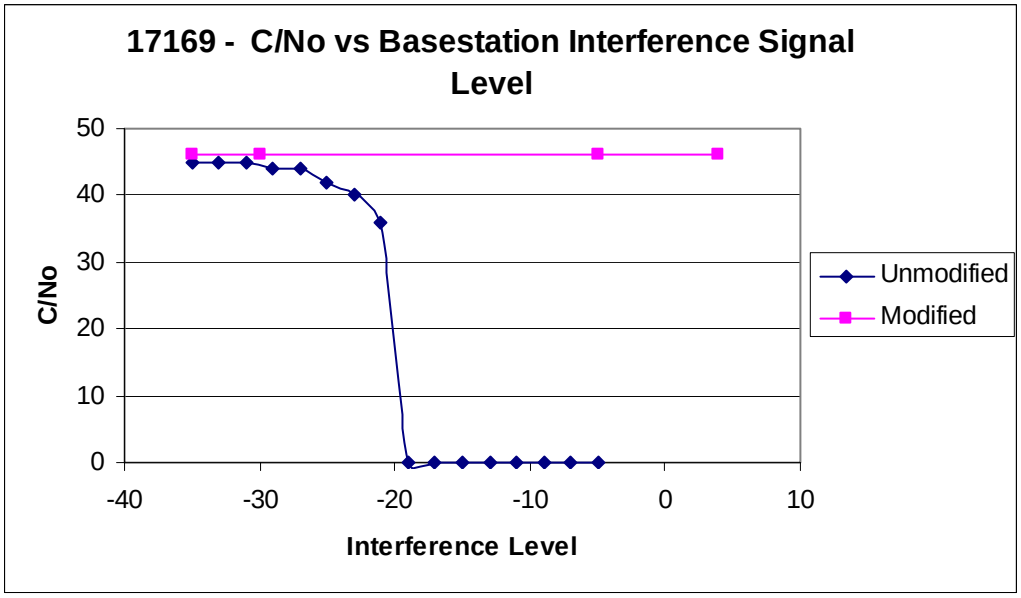
ATTACHMENT B
(Tracking with a Simulated GPS Signal)

Tracking Test Summary

Device	Configuration	Power @ Device dbm 1 C/No change Un-modified Ant	Power @ Device dbm 1 C/No change Modified Ant.	Notes:
12586 &17641	LTE Only	-29	No Change @ -15dbm	spreadsheet
	Handset Only (Both 1632.5 and 1651.7 MHZ)	-32	No Change @ -15dbm	
	LTE and Handset		No Change @ -15dbm	
	Live Satellite LTE Only		No Change @ -5dbm	
17169	LTE Only	-29	No Change @ -5dbm	
	Handset Only (Both 1632.5 and 1651.7 MHZ)	-34.4	No Change at -15 dBm	
	LTE and Handset	2 dB at -37	1.6 dB @ -10.4 dBm	
	Live Satellite LTE Only		No Change @ -5dBm	

Tracking Test Charts of C/No vs Interference
Simulated Satellite - Base Station Signal (Configuration 1)





1. Java Unit - Simulated GPS signal (started at -35 dBm, went to -10 dBm and and them returned to -35 dBm)

C/No Unmodified Ant-12867	C/No Modified – Ant-11207	PWR @ Device (dBm)
47	48	-35.00
47	48	-33.00
47	48	-31.00
46	48	-29.00
46	48	-27.00
44	48	-25.00
42	48	-23.00
38	48	-21.00
36	48	-19.00
32	48	-17.00
LOL * Note 1	48	-15.00
LOL	48	-13.00
LOL	48	-11.00
LOL	48	-10.00 Note 2
LOL	48	-11.00 Note 3
LOL	48	-13.00
LOL	48	-15.00
LOL	48	-17.00
LOL	48	-19.00
LOL	48	-21.00
42	48	-23.00
45	48	-25.00
46	48	-27.00
47	48	-29.00
47	48	-31.00
47	48	-33.00
47	48	-35.00

Note 1 – LOL indicates where the GPS units lost the GPS signal.
Note 2 - -10 dBm at the device is the maximum interference signal tested.
Note 3 – The interference signal was reduced to determine at what level the DUT signal would reacquire the DUT signal.

2. 17169

A. Simulated GPS with a constant GPS signal. Data also shows hysteresis performance for the unit connected to the unmodified antenna.

UNMODIFIEDANT -

GPS Status	PWR @ Device (dBm)
Lock	-35
Lock	-33
Lock	-31
Lock	-29
Lock	-27
Lock	-25
Lock	-23
Lock	-21
LOL	-19
LOL	-21
LOL	-23
LOL	-25
Mostly Back	-27
All Back	-29
Lock	-31
Lock	-33
Lock	-35

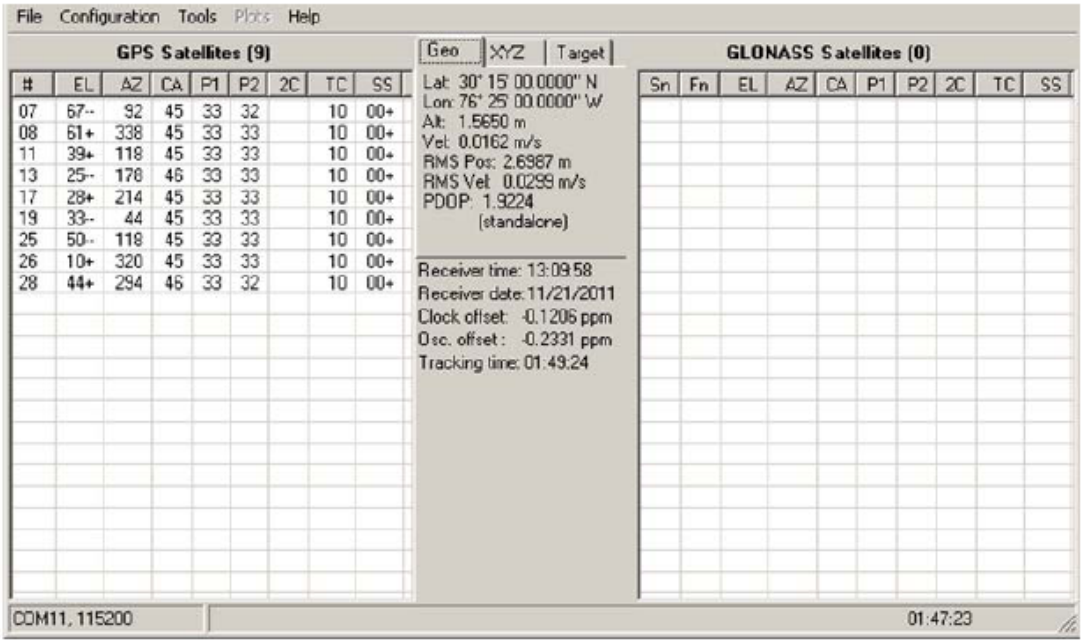
Modified Antenna-

GPS Status	PWR@ Device (dBm)
Lock	-35
Lock	-30
Lock	-5

NOTE 1 - Signal was reduced until Loss of Lock (LOL) was obtained on the unmodified antenna The signal was then increased until all satellites were reacquired.
NOTE 2 - For the modified antenna, only four signal levels were used based on previous test results which showed the modified antenna was not affected at the lower signal levels.

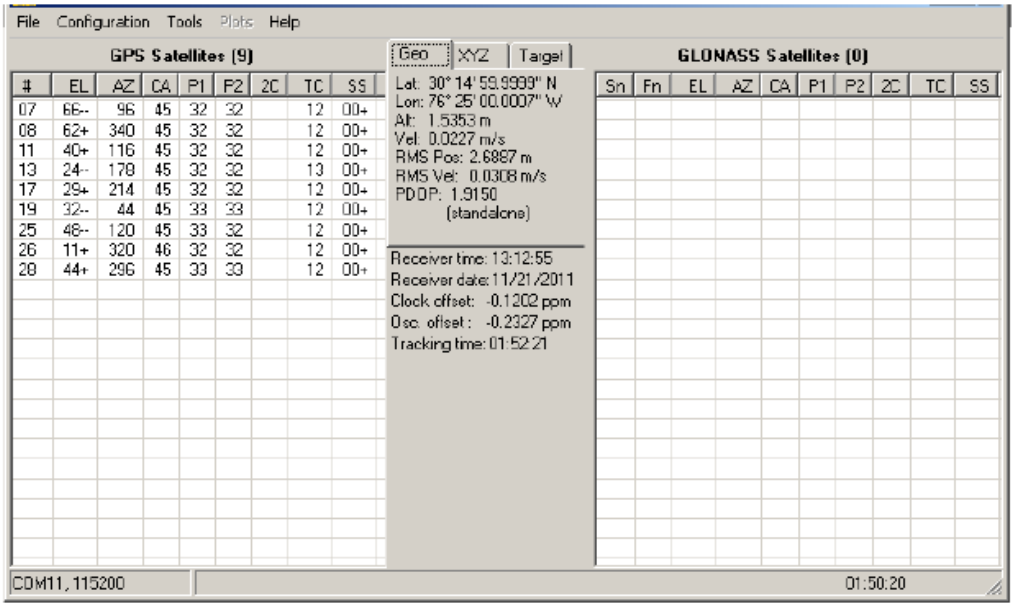
B. 17169 GPS unit with unmodified antenna with no interference

No Interference

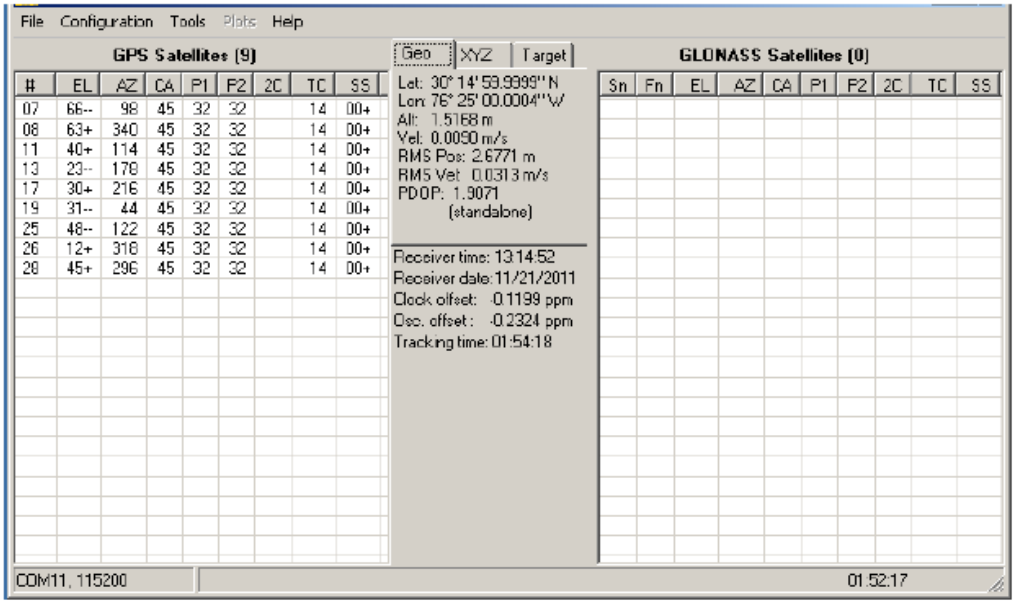


B. 17169 GPS unit with unmodified antenna with interference (increased level to -19 dBm until loss of lock and then decreased level of interference)

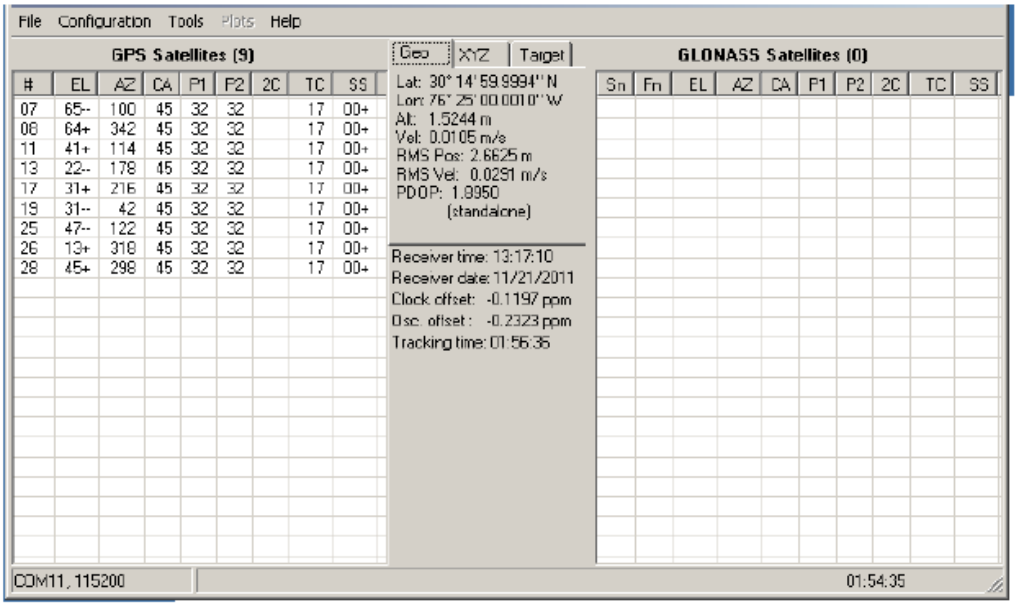
Interference Level -35dbm @ device



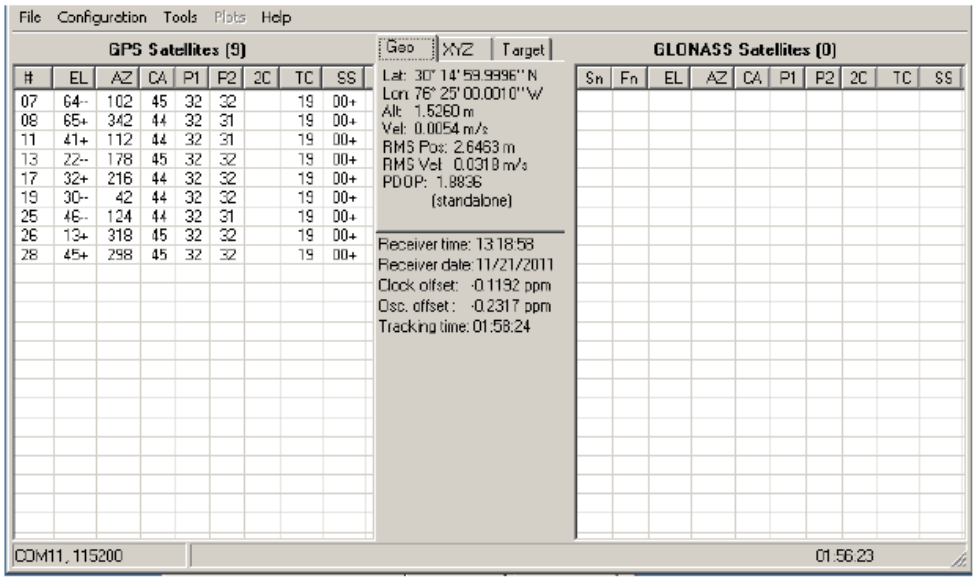
Interference Level -33dbm @ device



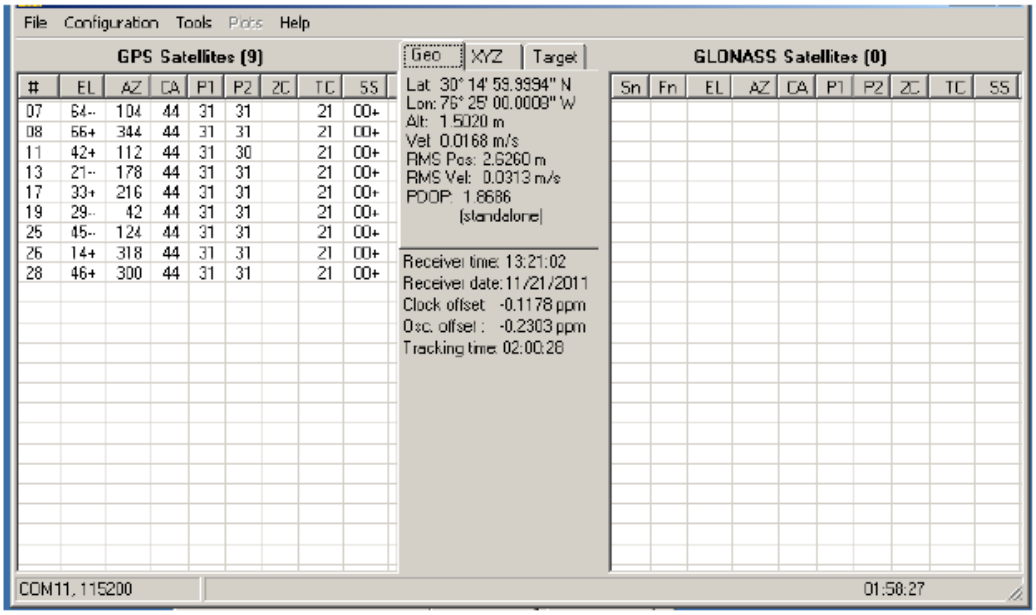
Interference Level -31dbm @ device



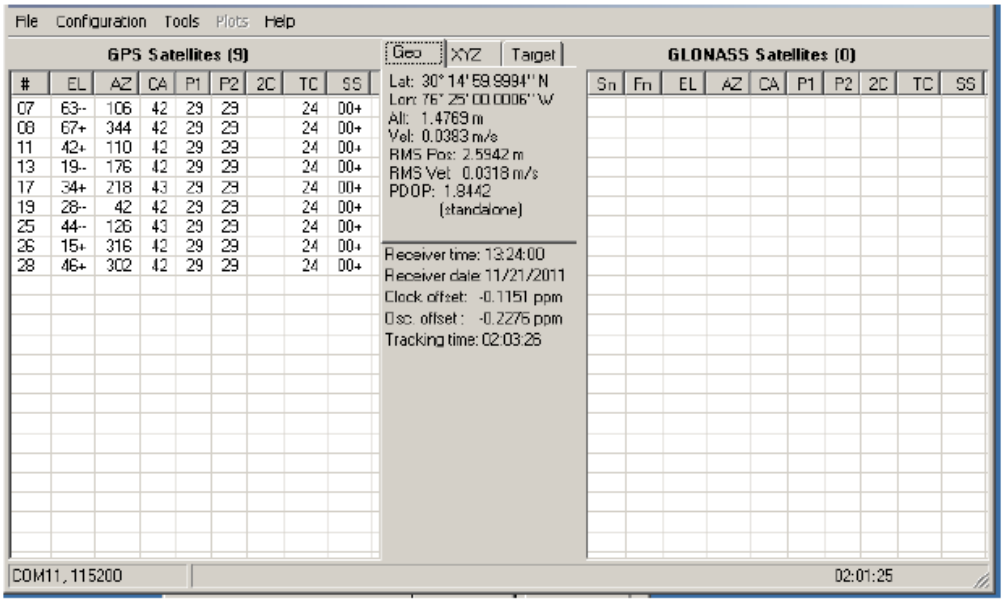
Interference Level -29dbm @ device



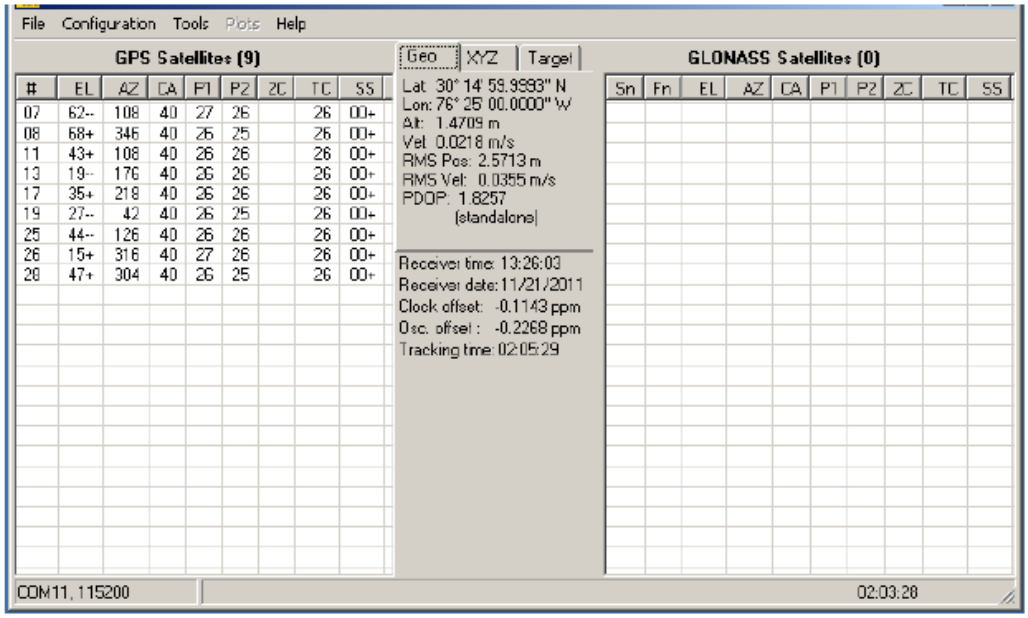
Interference Level -27dbm @ device



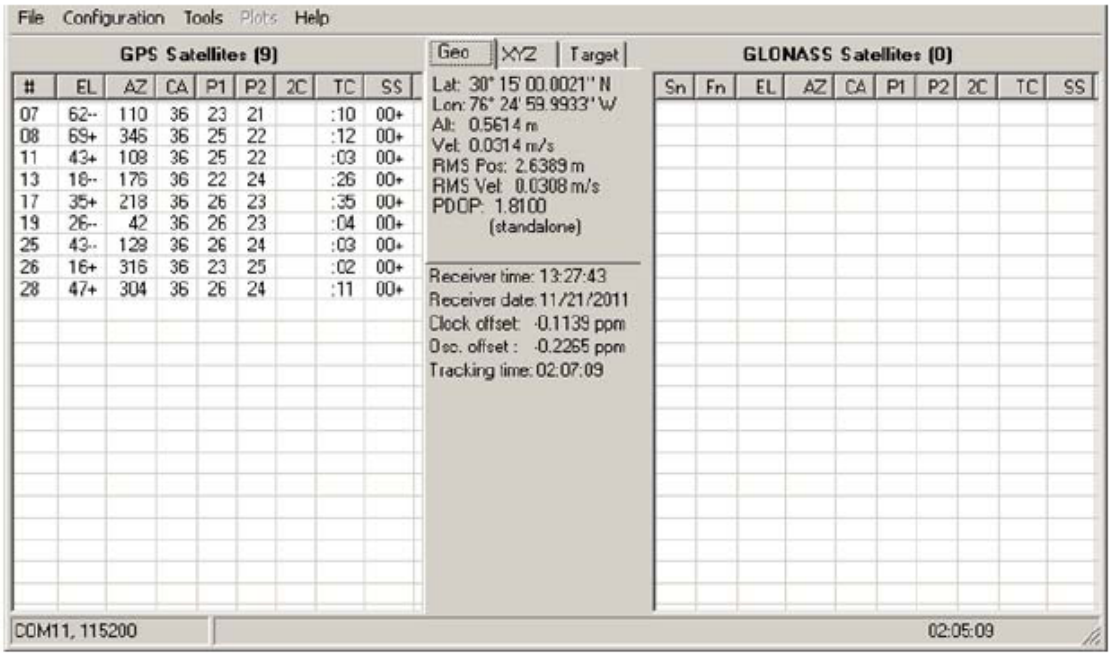
Interference Level -25dbm @ device



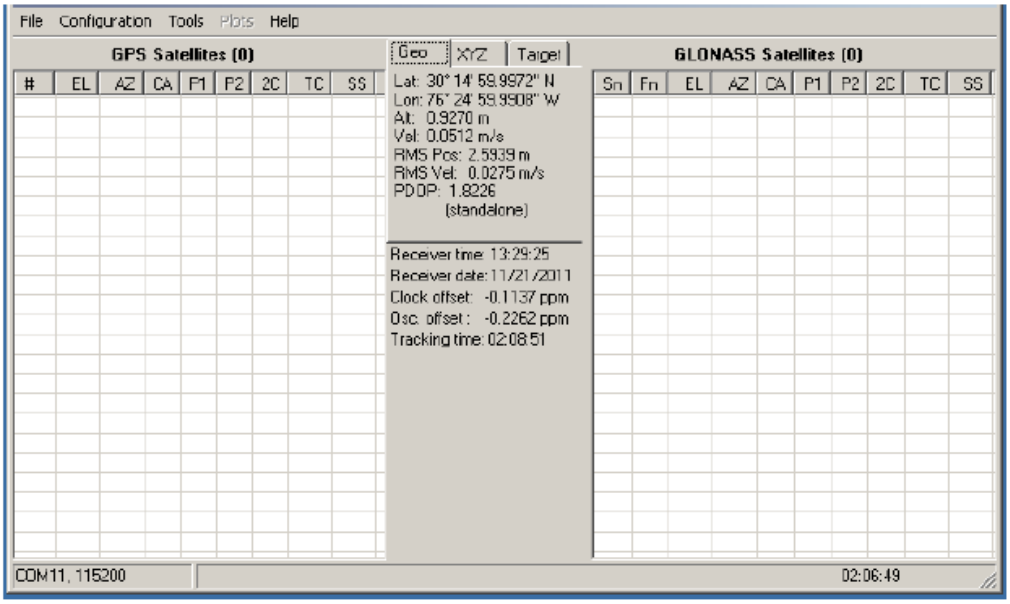
Interference Level -23dbm @ device



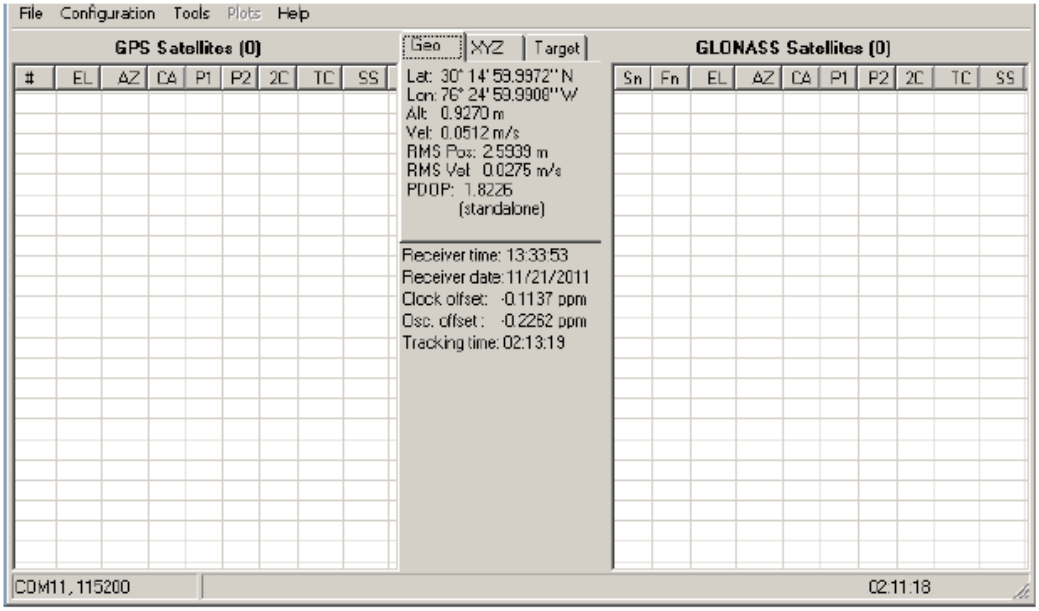
Interference Level -21dbm @ device



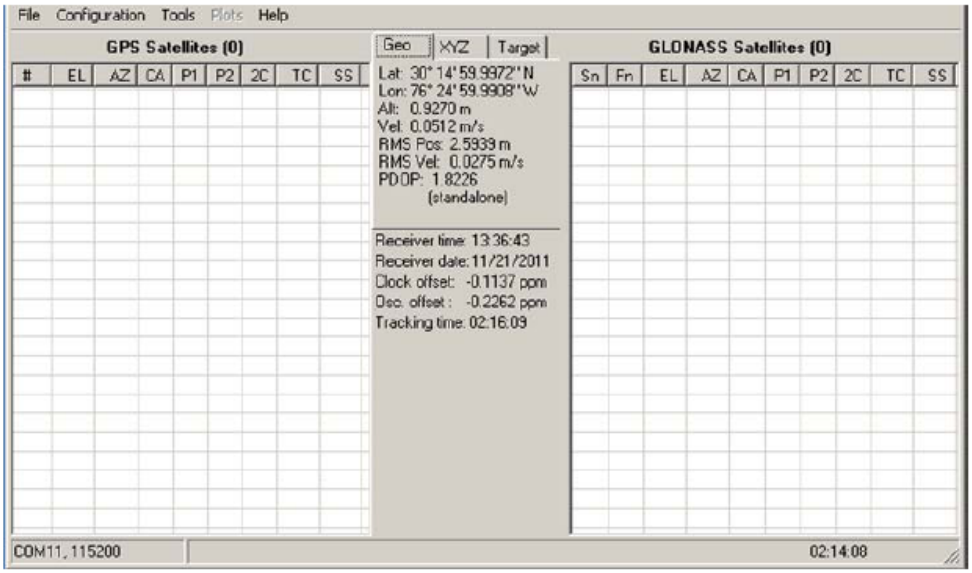
Interference Level -19dbm @ device



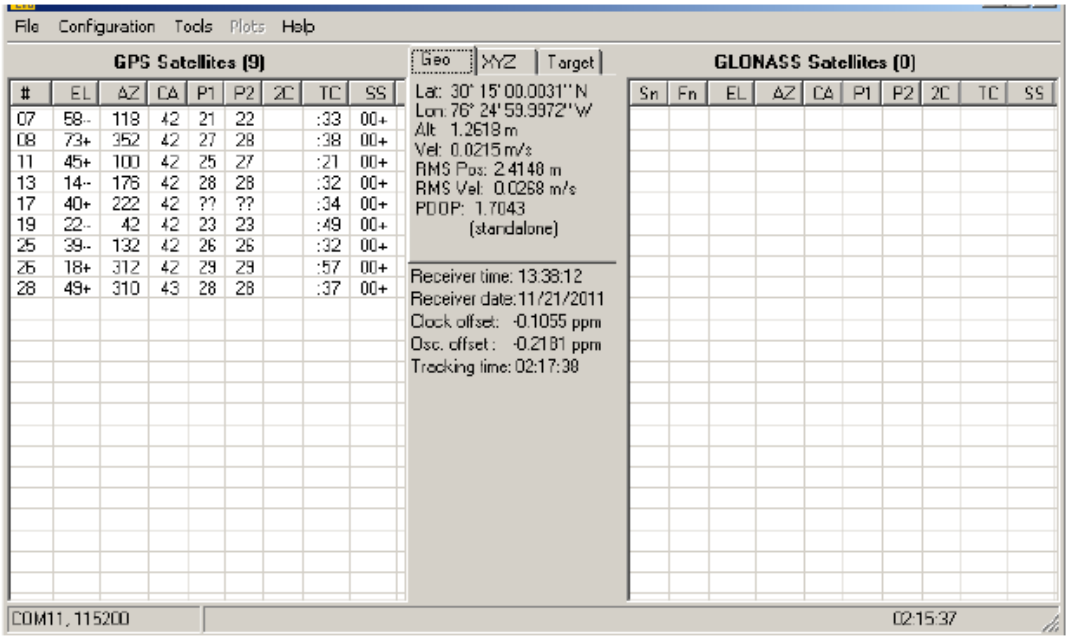
Interference Level -21dbm @ device



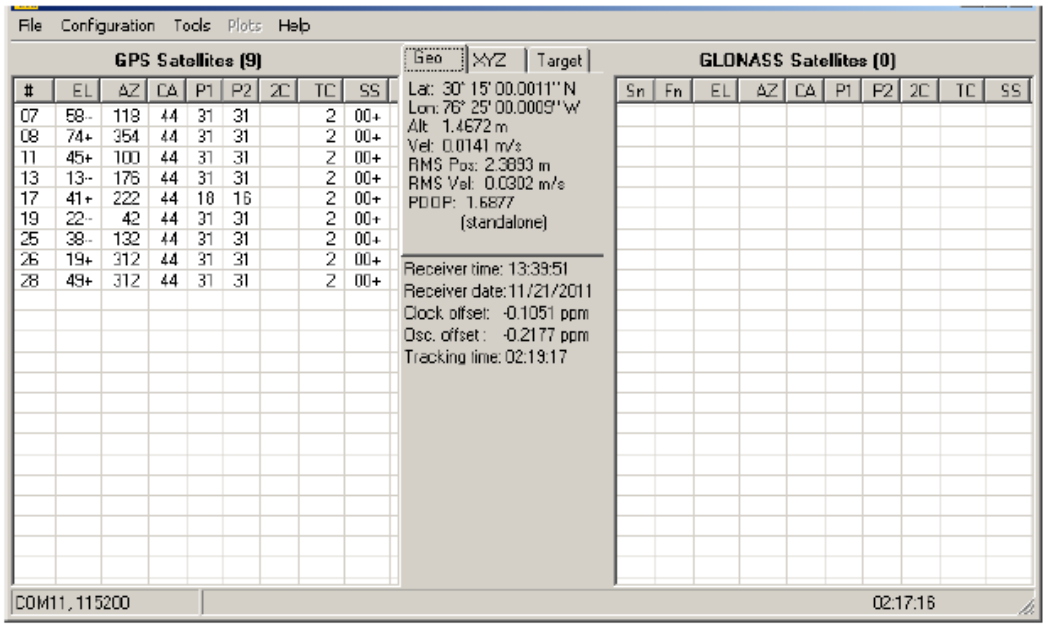
Interference Level -23dbm @ device



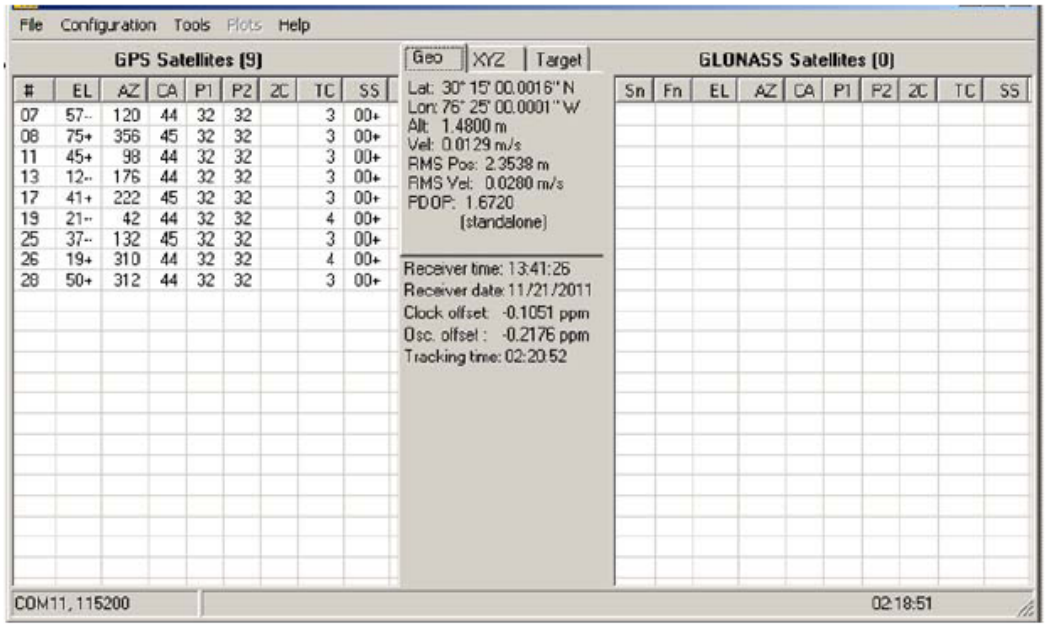
Interference Level -25dbm @ device



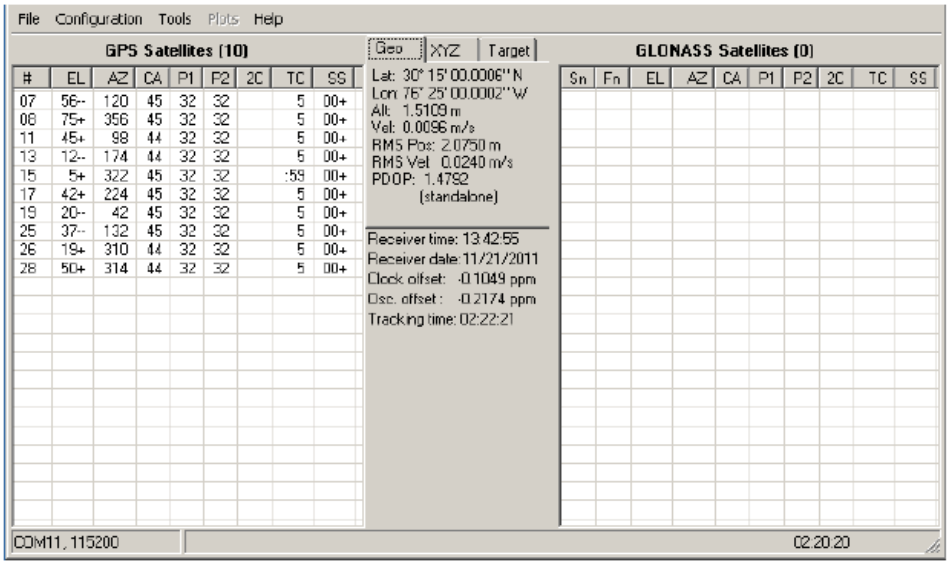
Interference Level -27dbm @ device



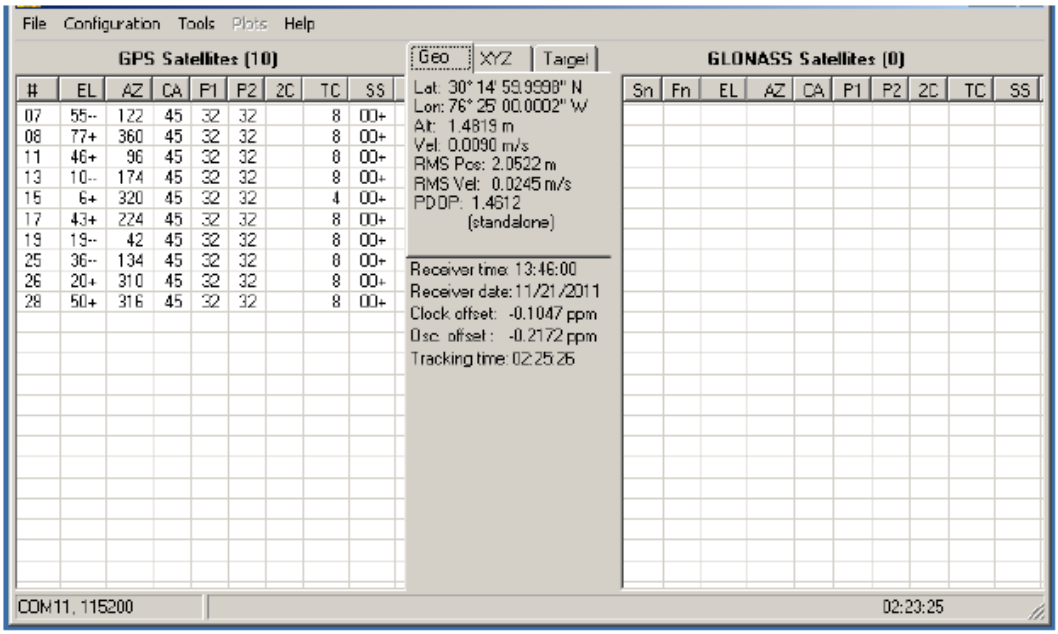
Interference Level -29dbm @ device



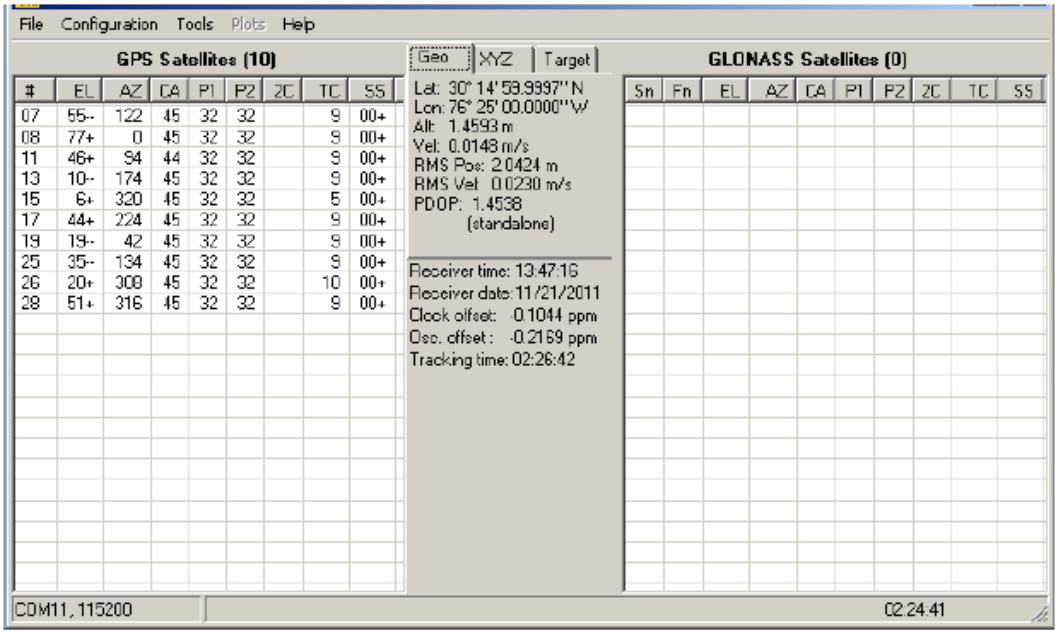
Interference Level -31dbm @ device



Interference Level -33dbm @ device

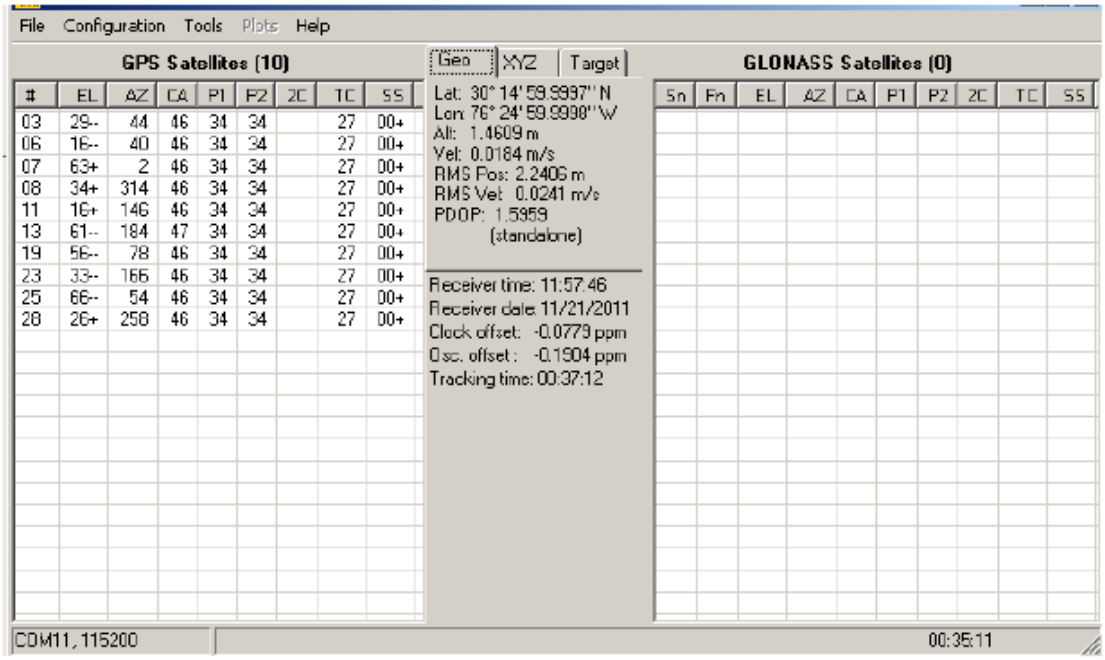


Interference Level -35dbm @ device



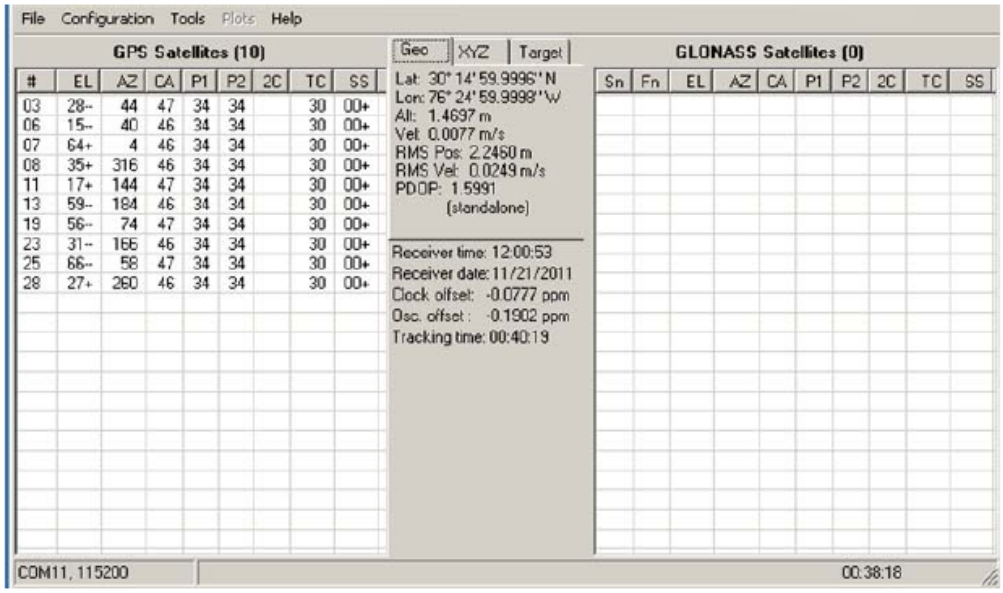
C. 17169 Unit with modified antenna no interference.

No Interference

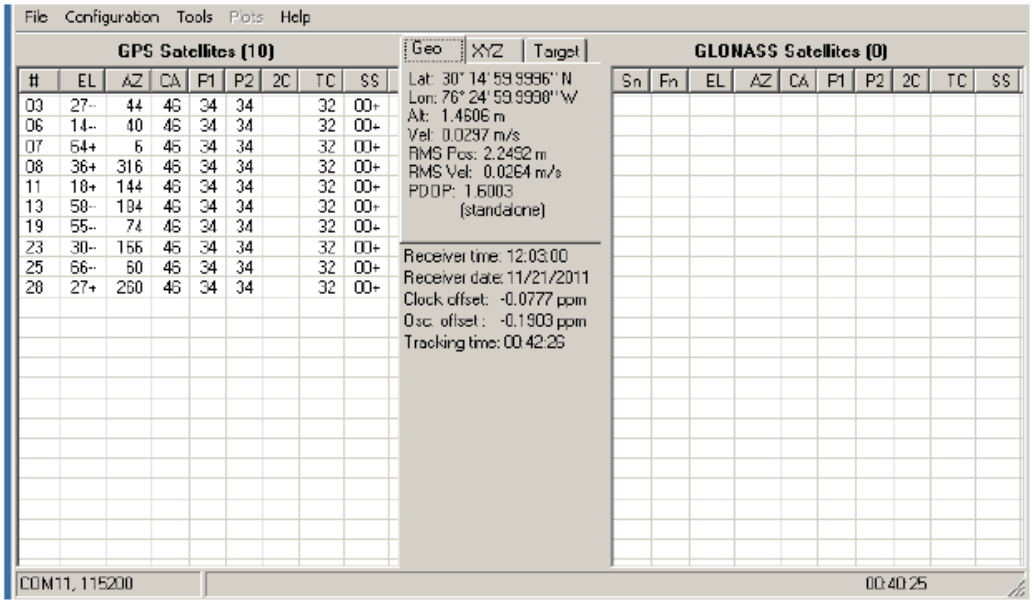


D. 17169 Unit with modified antenna with interference.

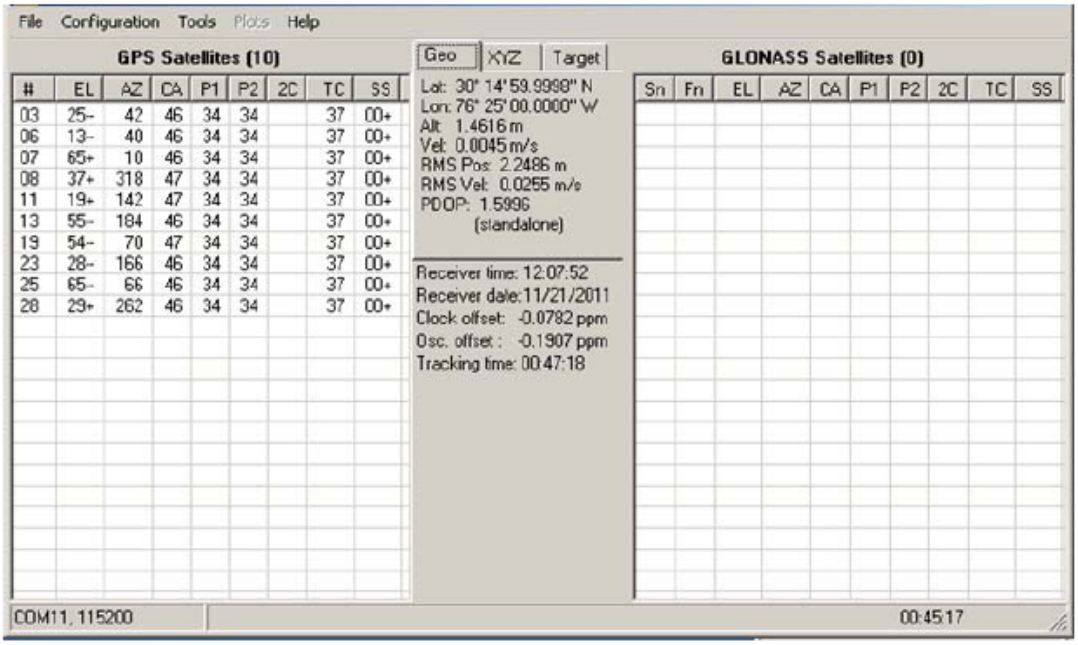
Interference Level -35dbm @ device



Interference Level -30dbm @ device



Interference Level -5dbm @ device

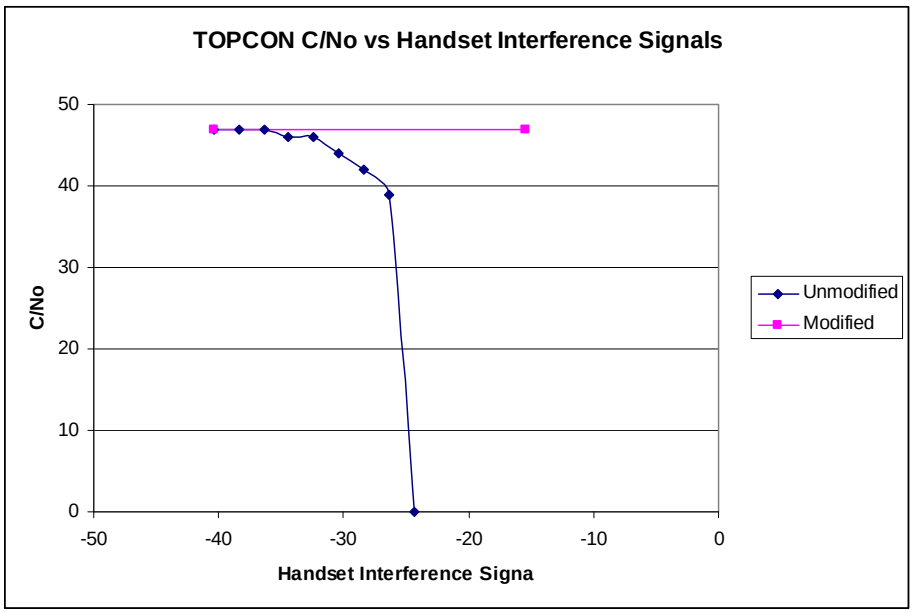


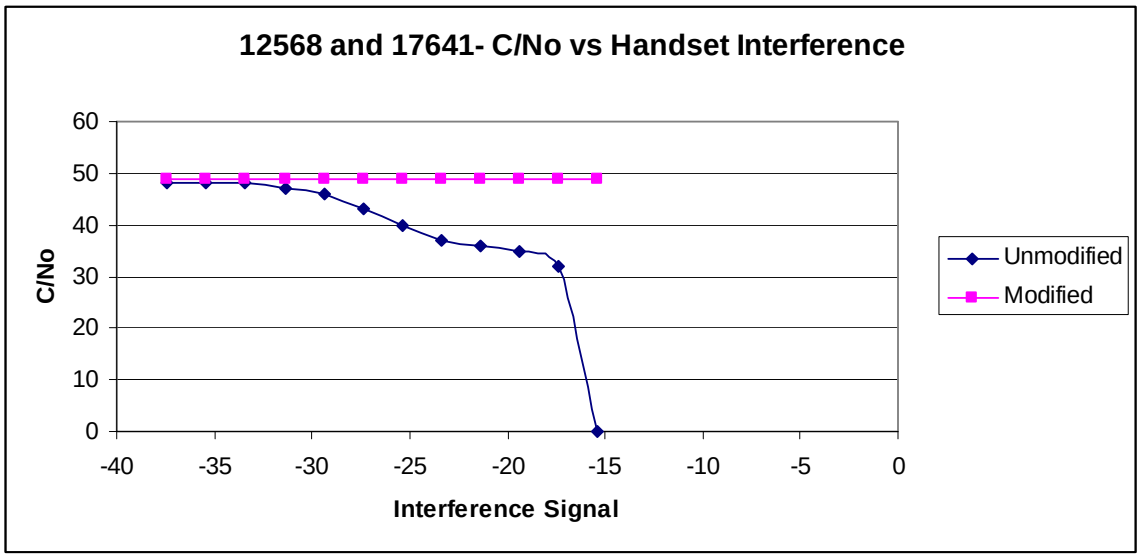
ATTACHMENT C

(Tracking – Uplink)

TRACKING – Handset
(UPLINK- 1632.5 and 1651.7MHz Combined Signal)

1. Charts of C/No vs the handset interfering signals (1632.5 and 1651.7 Combined)





2. 17169 – Handset Interfering Signal (Combined 1632.5 and 1651.7)

GPS Status	PWR @ Device (dBm)
47	-40.4
47	-38.4
47	-36.4
46	-34.4
46	-32.4
44	-30.4
42	-28.4
39	-26.4
LOL	-24.4
LOL	-22.4
LOL	-24.4
LOL	-26.4
LOL	-28.4
44	-30.4
46	-32.4
46	-34.4
47	-36.4

GPS Status	PWR@ Device (dBm)
47	-40.4
47	-15.4

3. 12586 AND 17641 – Handset Interfering Signal (Combined 1632.5 and 1651.7)

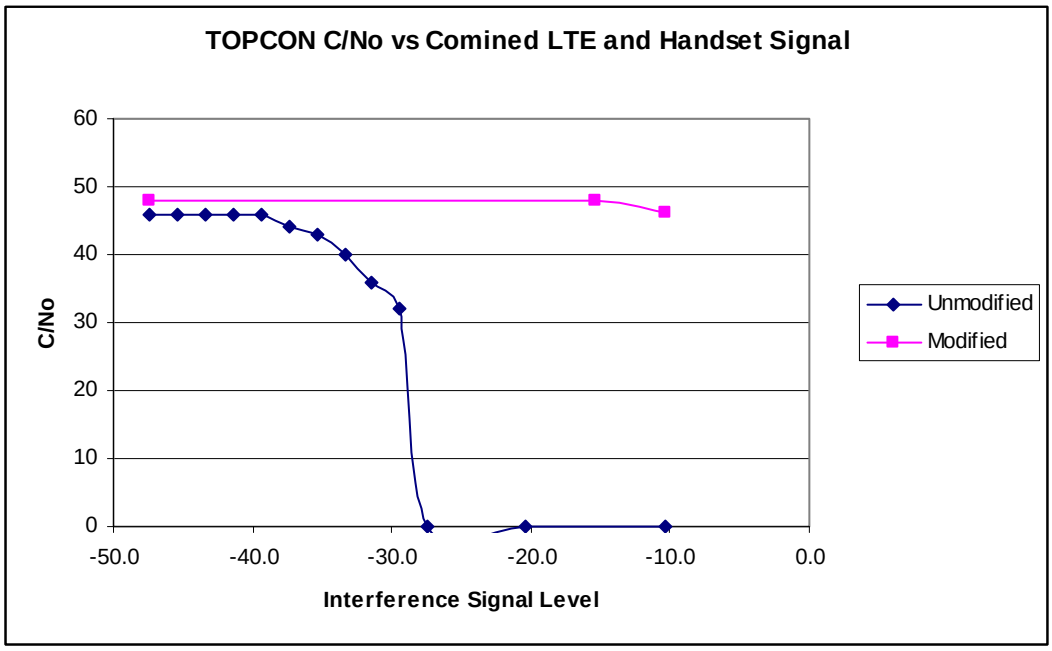
GPS Status	PWR @ Device (dBm)
48	-37.40
48	-35.40
48	-33.40
47	-31.40
46	-29.40
43	-27.40
40	-25.40
37	-23.40
36	-21.40
35	-19.40
32	-17.40
0	-15.40
0	-17.4
0	-19.40
0	-21.4
0	-23.40
0	-25.4
0 (Located 2)	-27.4
46	-29.40
48	-31.4
48	-33.40
48	-35.4
48	-37.4

GPS Status	PWR@ Device (dBm)
49	-37.40
49	-35.40
49	-33.40
49	-31.40
49	-29.40
49	-27.40
49	-25.40
49	-23.40
49	-21.40
49	-19.40
49	-17.40
49	-15.40

ATTACHMENT D
(Tracking – Combined LTE and Handset Signals)

TRACKING – LTE and Handset Signals Combined

1. Charts of C/No vs the combined LTE and handset interfering signals



2. 17169 – LTE and Handset Interfering Signals combined

GPS Status	PWR @ Device (dBm) HDST	PWR @ Device (dBm) HDST
46	-30.0	-47.4
46	-30.0	-45.4
46	-30.0	-43.4
46	-30.0	-41.4
46	-30.0	-39.4
44	-30.0	-37.4
43	-30.0	-35.4
40	-30.0	-33.4
36	-30.0	-31.4
32	-30.0	-29.4
lol	-30.0	-27.4
lol	-30.0	-29.4
lol	-30.0	-31.4
lol	-30.0	-33.4
43	-30.0	-35.4
44.5	-30.0	-37.4
45	-30.0	-39.4
46	-30.0	-41.4
46	-30.0	-43.4
46	-30.0	-45.4
46	-30.0	-47.4

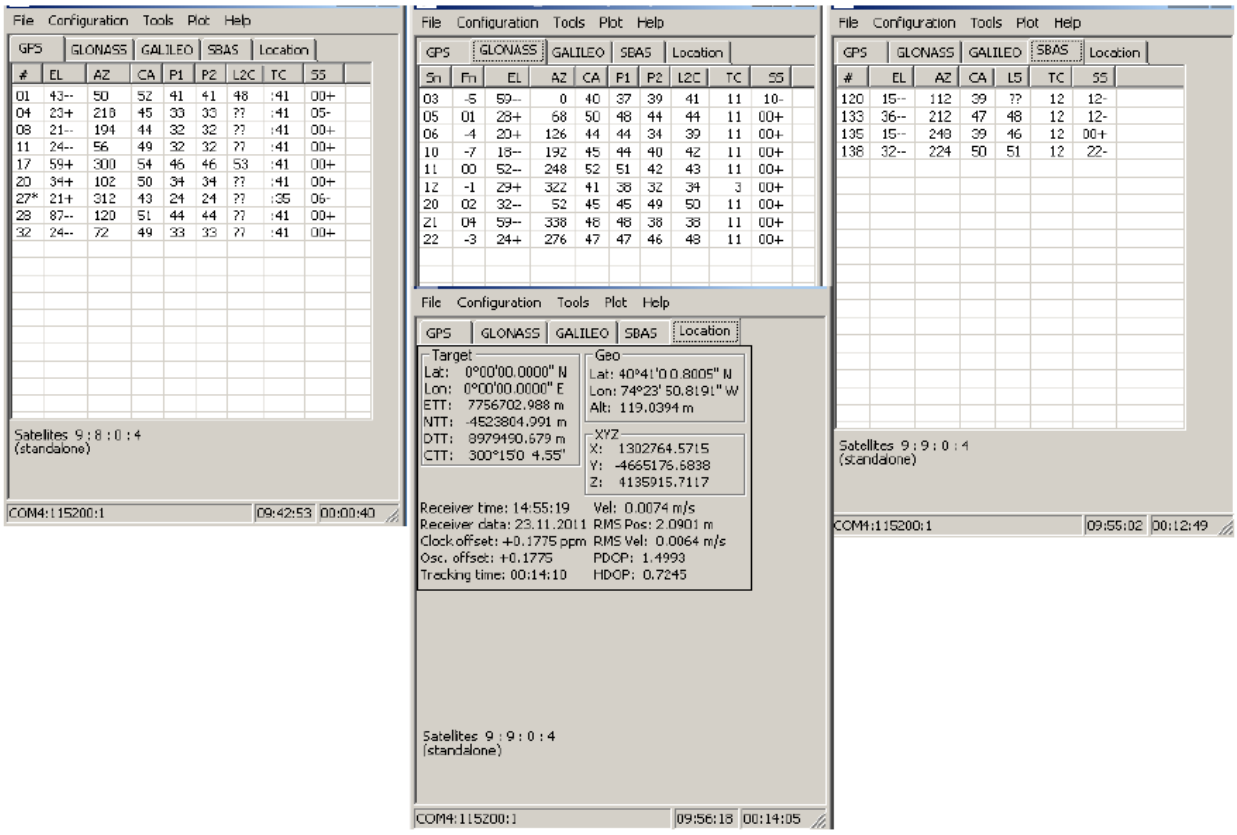
GPS Status	PWR@ Device (dBm) LTE	PWR@ Device (dBm) HDST
47.8	-15.0	-47.4
47.8	-15.0	-15.4
46.2	-10.0	-10.4

ATTACHMENT E

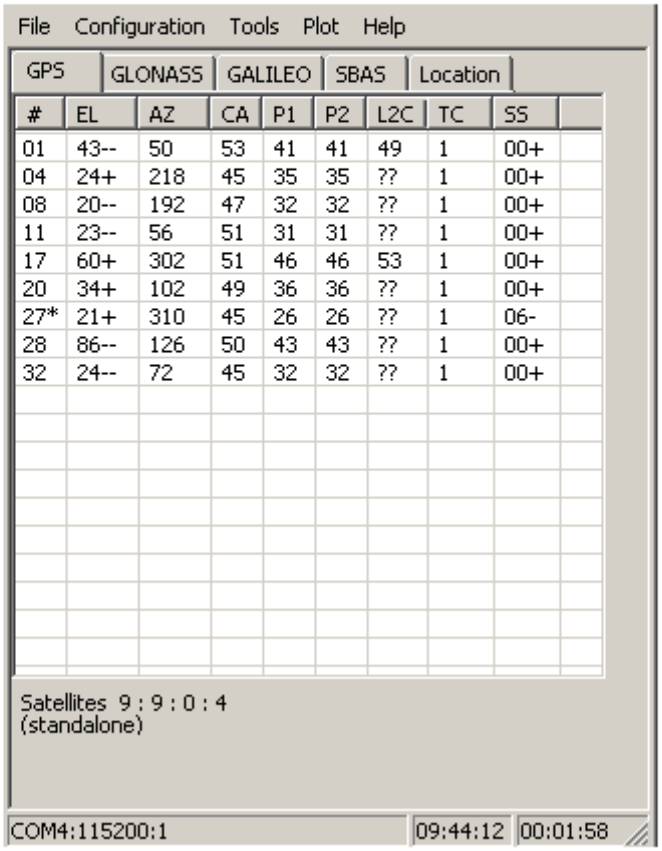
(Live Satellite Tracking – Base Station)

17169 GPS with Modified Antenna

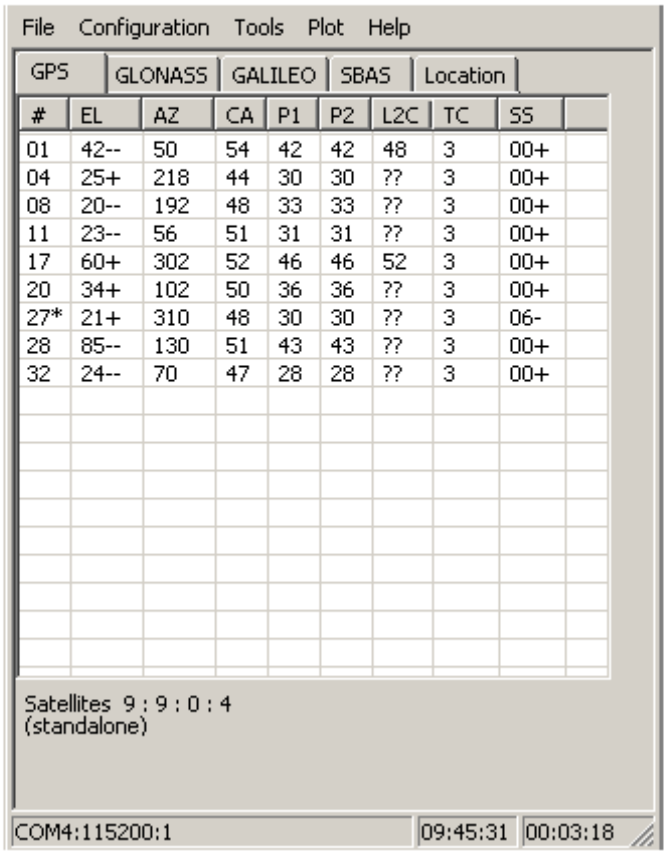
No Interference



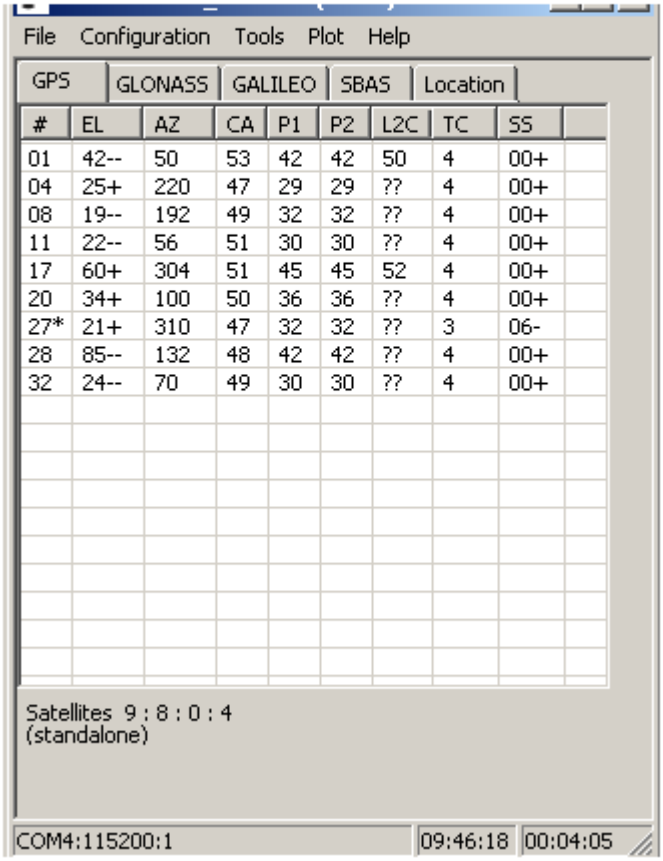
Interference -35dBm



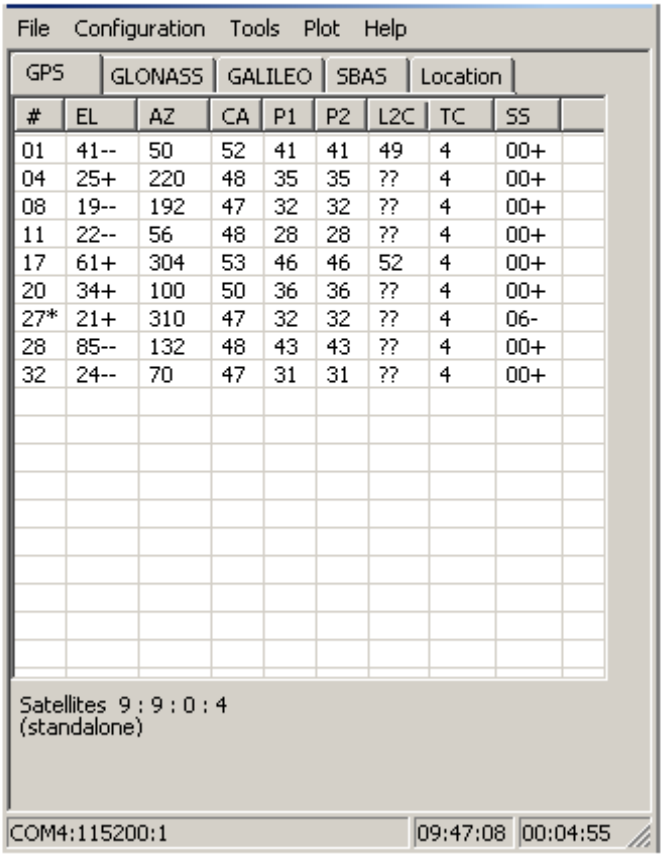
Interference -30dBm



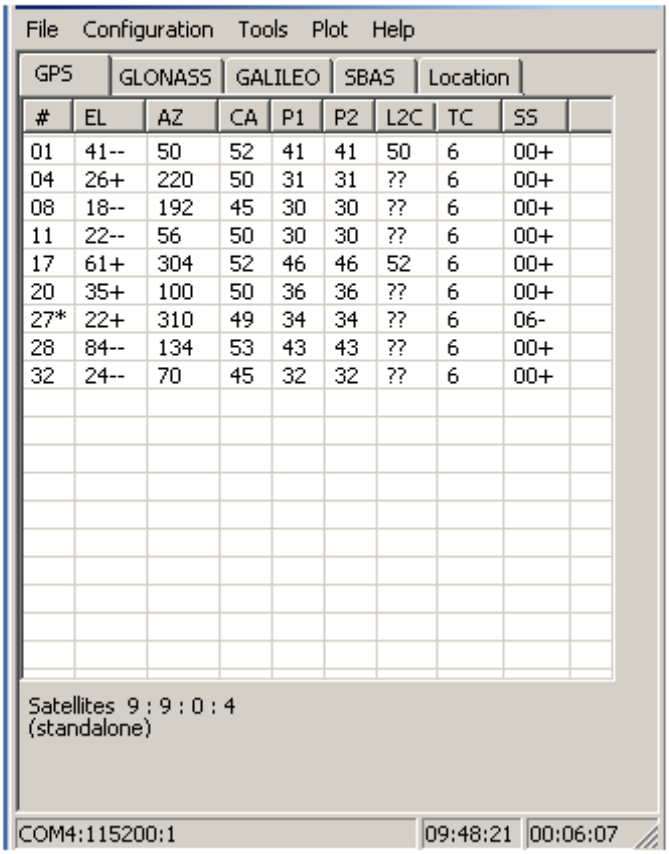
Interference -25dBm



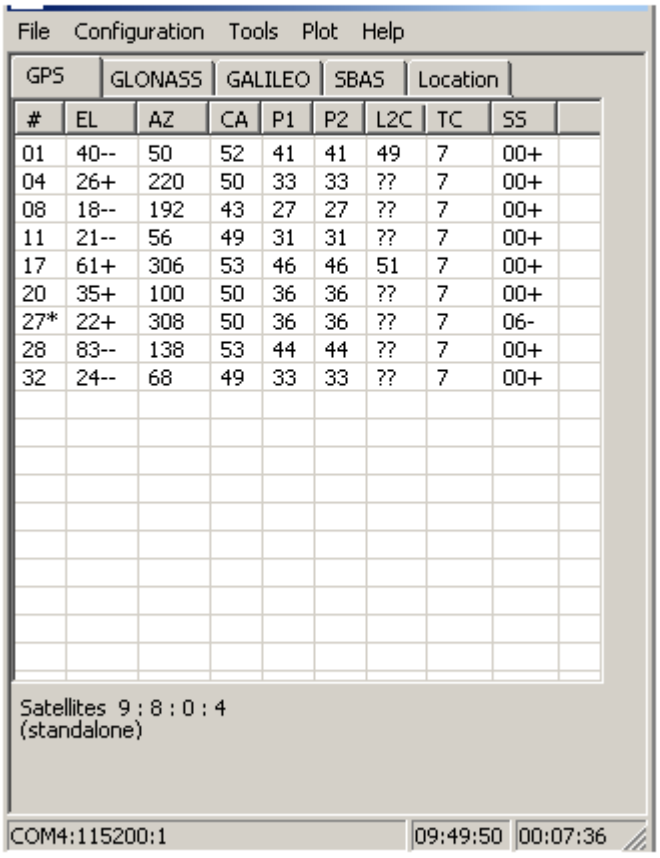
Interference -20dBm



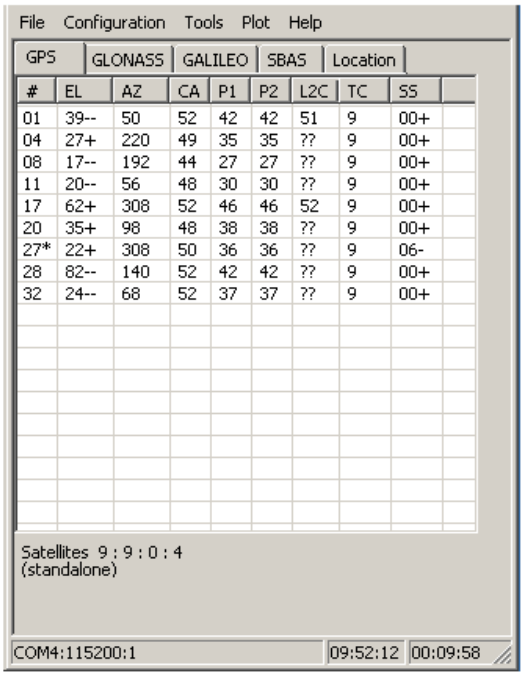
Interference -15dBm

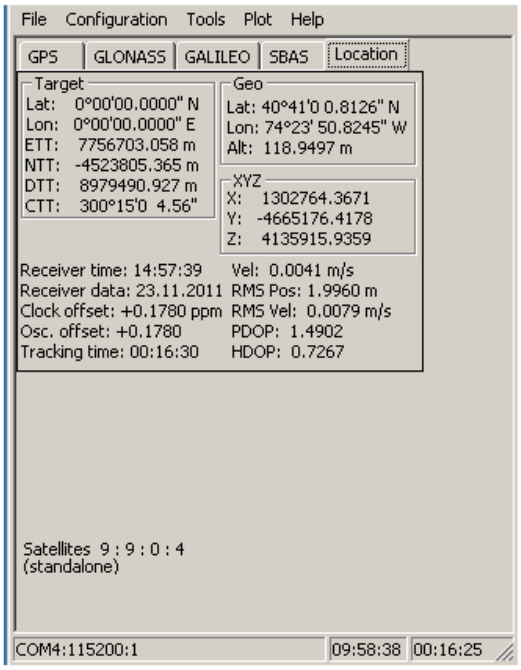


Interference -10dBm



Interference -5dBm





ATTACHMENT F
(Acquisition)

ACQUISITION
(max time 3 minutes)

1. 12586 and 17641 Units using a modified antenna and an unmodified antenna

LTE PWR @ device (dBm)	Time (Seconds) Unmodified Ant	Modified Ant	Field V/M
-30	8	8	
-24	20	10	
-20	FTA	15	1.04
-14	FTA	12	2.4

*FTA- Failed to Acquire Signal

2. 17169 unit –tested with constant signal from simulator. Tested with a unmodified and modified antenna.

LTE PWR at device (dBm)	Time (Seconds) Unmodified Ant	Modified Ant	Field V/M
Baseline	2	5	
-30	8	29	
-24	55	130	
-20	DNFA	85	0.96
-15	DNA	80	2.2

*DNA- Failed to Acquire Signal
*DNFA - Did not fully acquire all Sats within 3 minutes

ATTACHMENT G

Sensitivity Testing
(Satellite Signal Reduced)

Sensitivity Test Summary

12586 AND 17641 GPS Devices

Interference Level	GPS Power Levels													
	-130 dBm		-135 dBm		-137dBm		-140		-145		-150		-155	
	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod
No Int	47	48	-4	-4	-6	-5	-8	-7					LOL	-23
-30	47	48	-4	-3	-6	-5	-8	-7					LOL	-23
-24	43	48	LOL	-3			LOL	-7					LOL	-23
-15	LOL	48												

17169 GPS Device

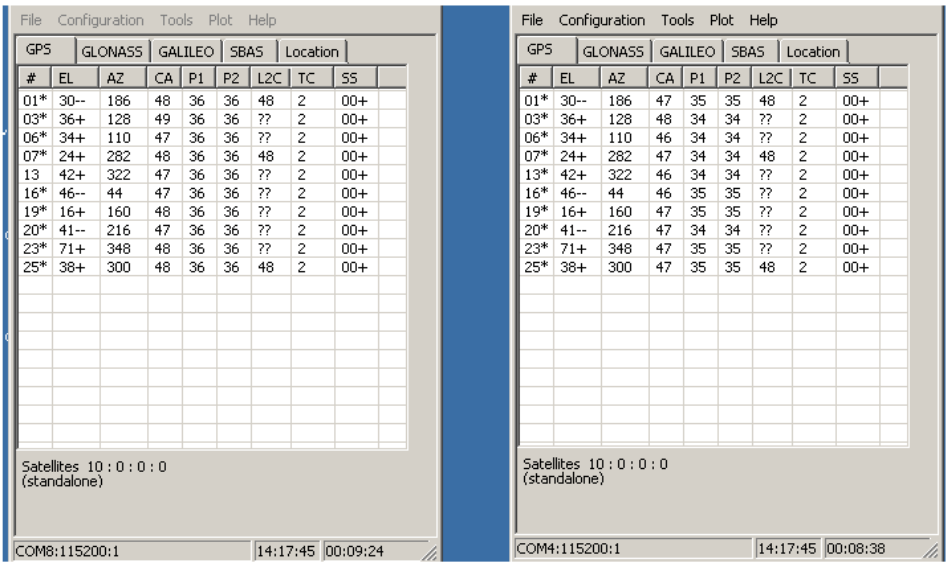
Interference Level	GPS Power Levels													
	-130 dBm		-135 dBm		-137dBm		-140		-145		-150		-155	
	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod	UnMod	Mod
No Int	46	46	-4	-3	-6	-4	-7	-7	-14	-12		-16		LOL
-30	45	46	-4	-3		-4		-7	-14	-12		-16		
-24	41	46	-4	-3			-13	-7		-12		-16		
-15		46		-3				-7				-16		

LOL – Loss of Lock

12586 AND 17641 GPS RECEIVER UNITS

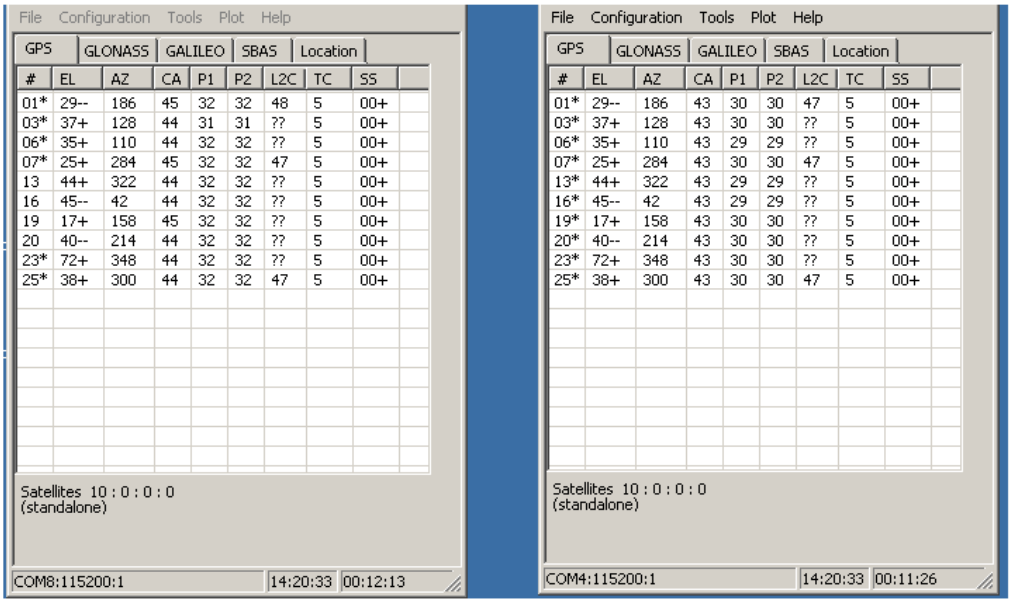
1. No Interference

No Interference, Psat = -130 dBm



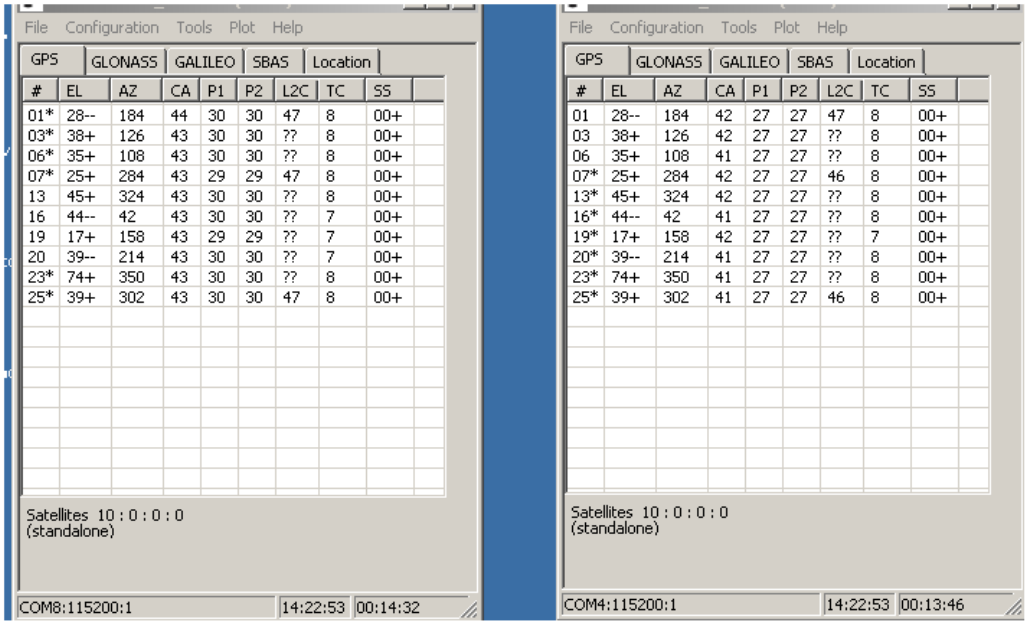
Modified Un-Modified

No Interference, Psat = -135 dBn



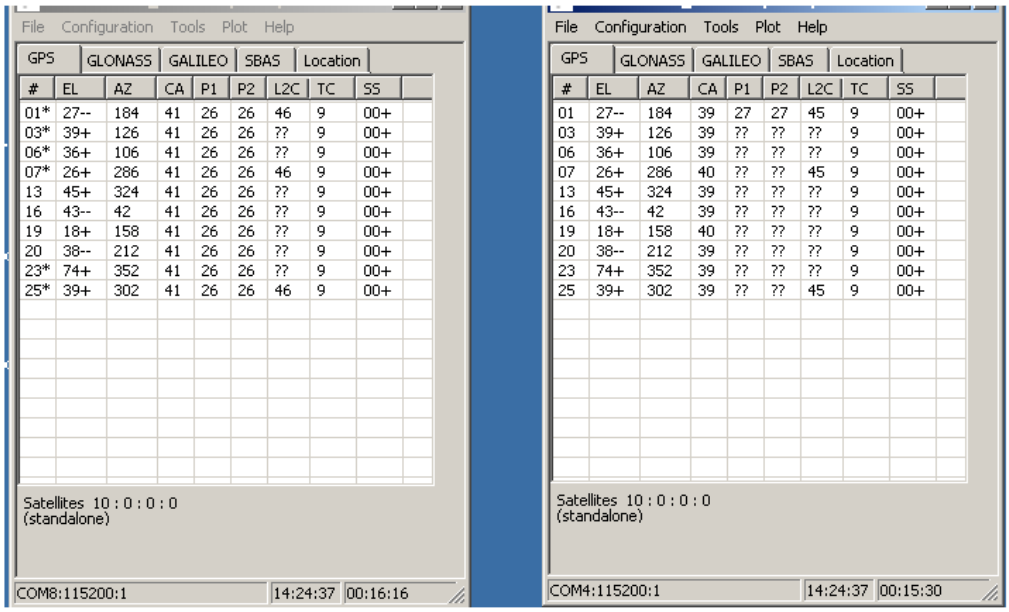
Modified Un-Modified

No Interference, Psat = -137 dBm



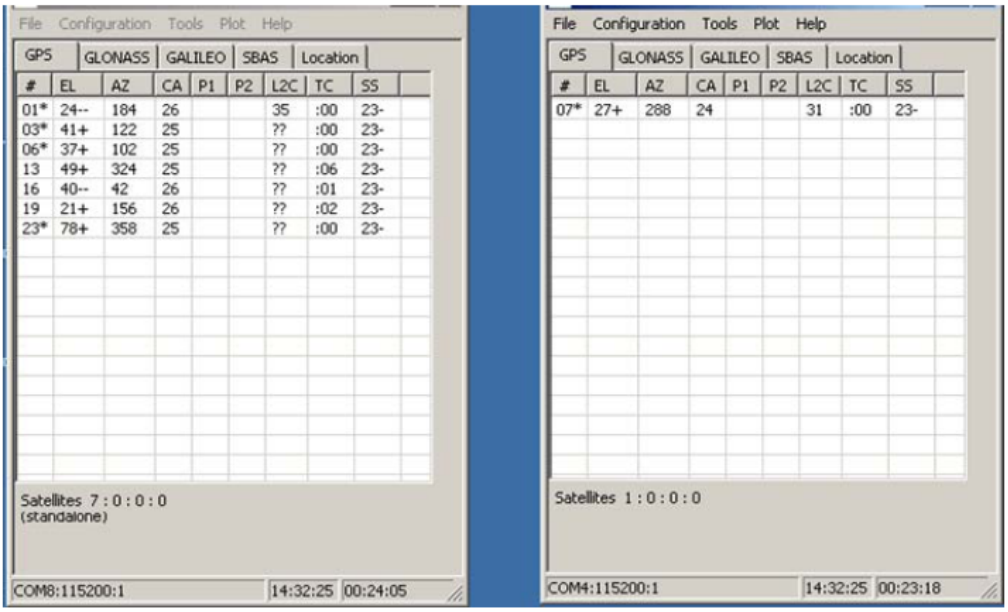
Modified Un-Modified

No Interference, Psat = -140 dBm



Modified Un-Modified

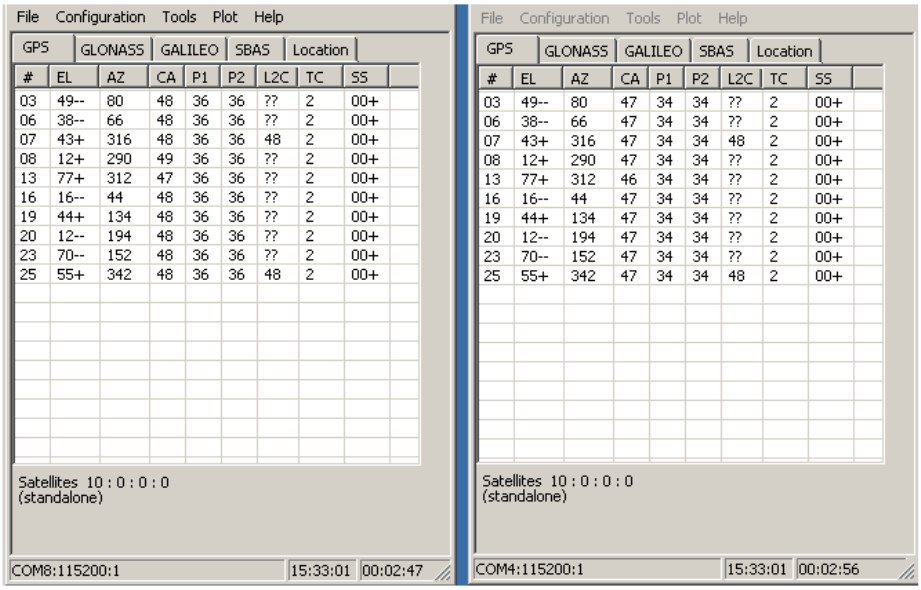
No Interference, Psat = -155 dBm



Modified Un-Modified

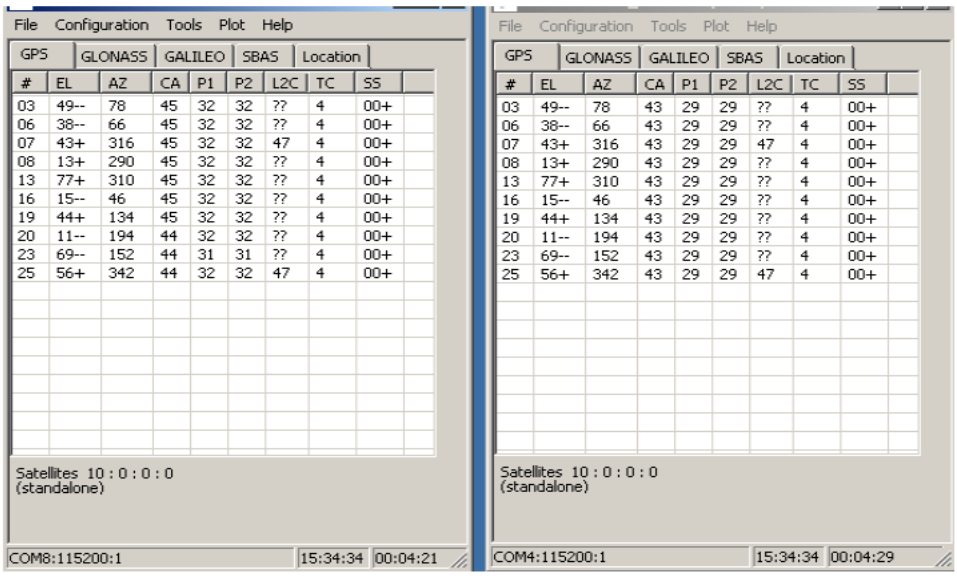
2. With Interference

Interference -30 dBm, Psat = -130 dBm



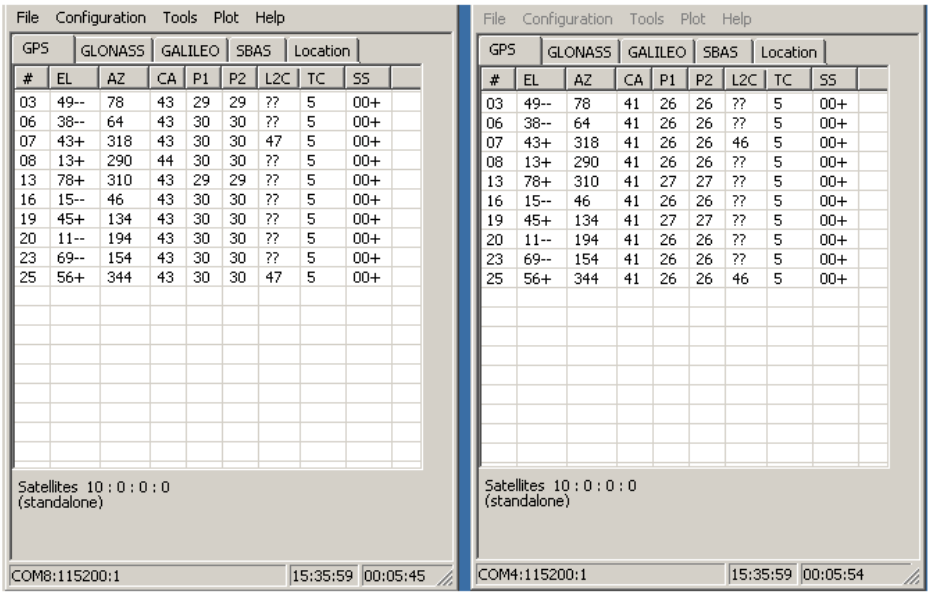
Modified Un-Modified

Interference -30dBm, Psat = -135 dBm



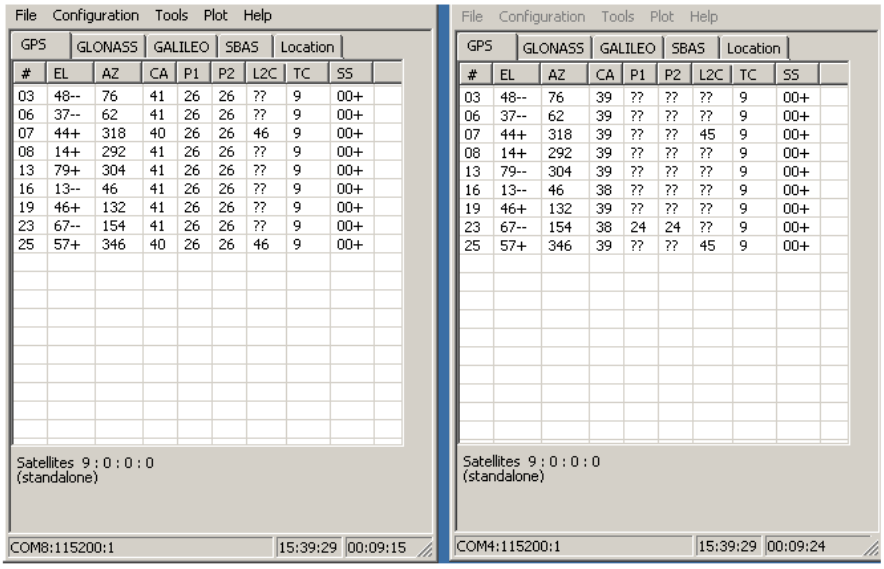
Modified Un-Modified

Interference -30dBm, Psat = -137 dBm



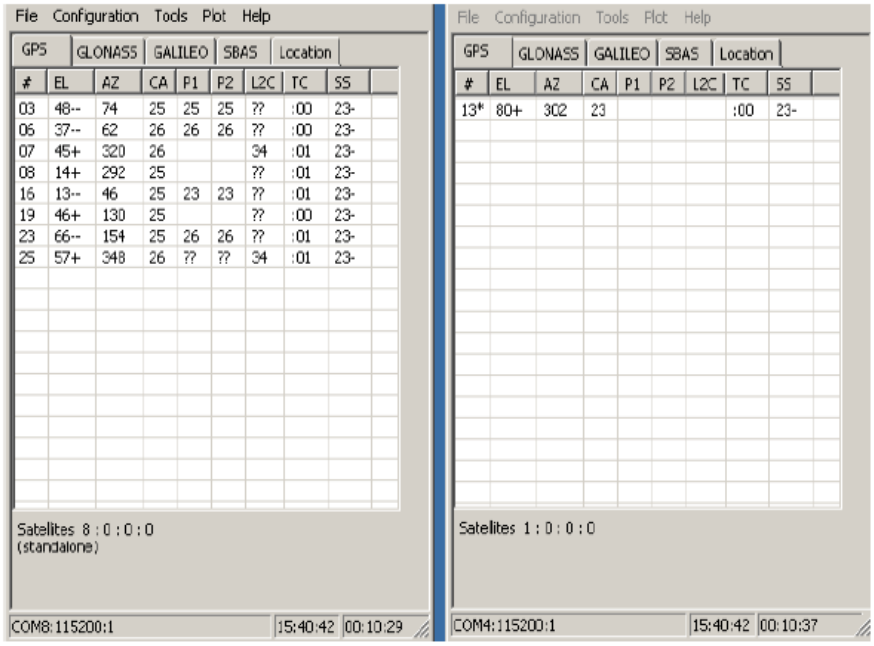
Modified Un-Modified

Interference -30dBm, Psat = -140 dBm



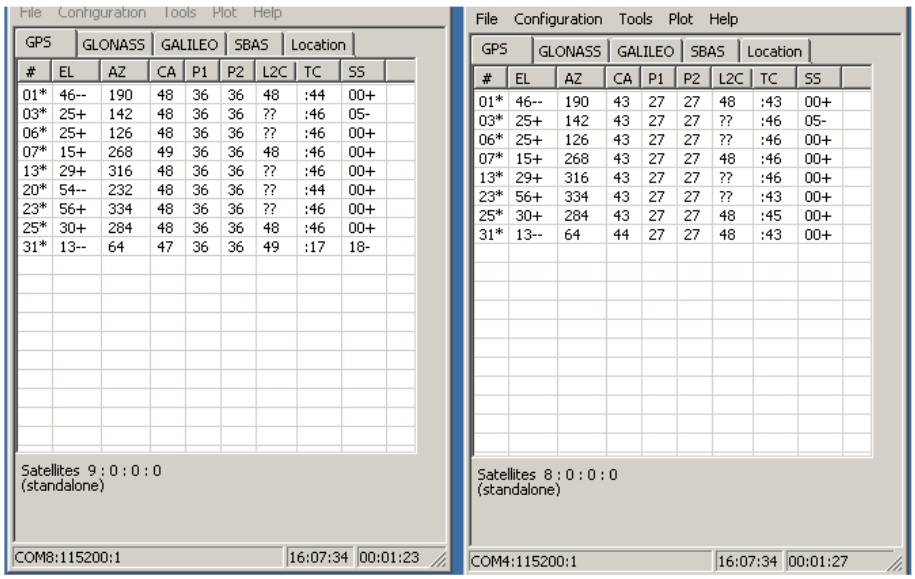
Modified Un-Modified

Interference -30dBm, Psat = -155 dBm



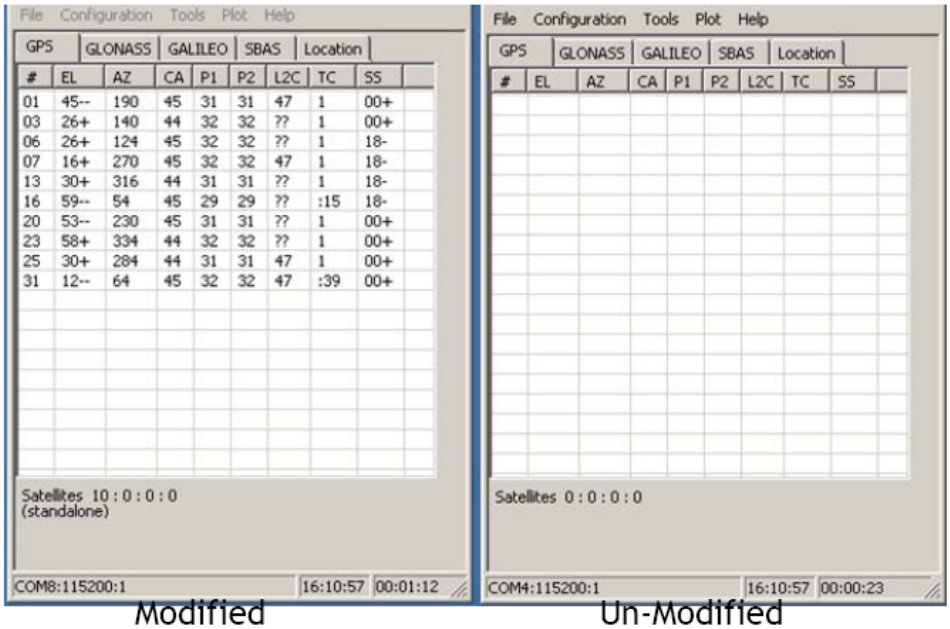
Modified Un-Modified

Interference -24dBm, Psat = -130 dBm



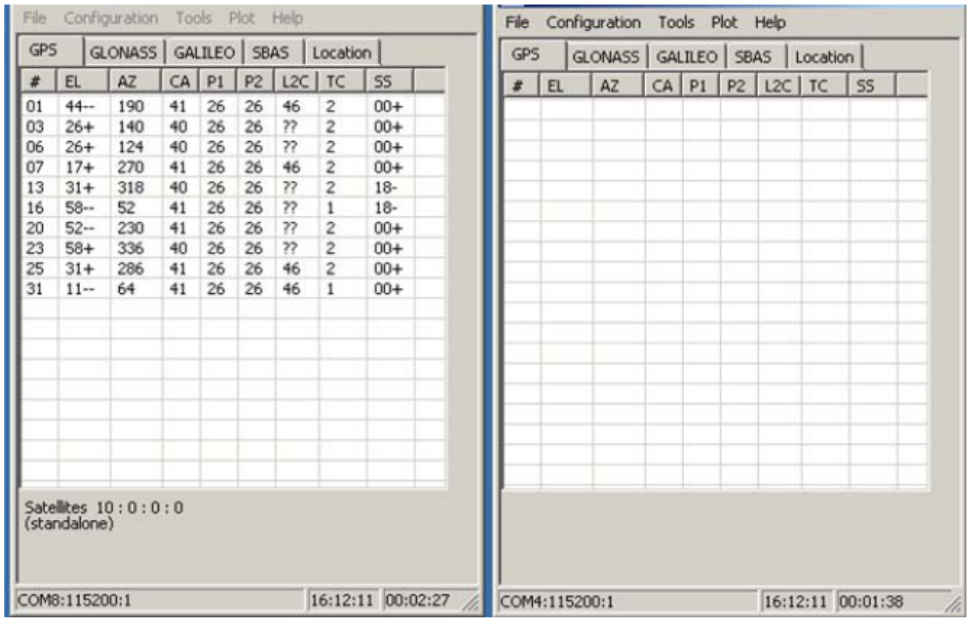
Modified Un-Modified

Interference -24dBm, Psat = -135 dBm



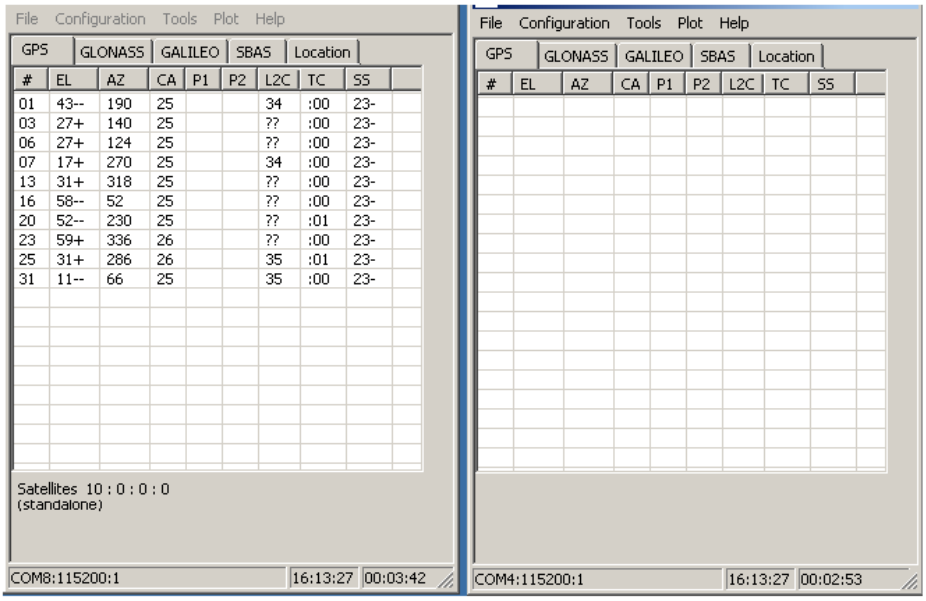
Modified Un-Modified

Interference -24dBm, Psat = -140 dBm



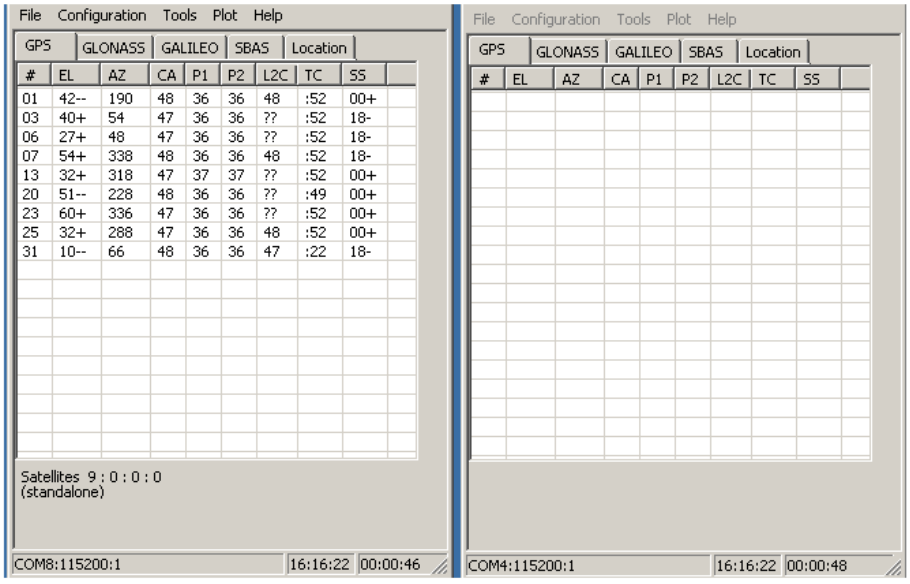
Modified Un-Modified

Interference -24dBm, Psat = -155 dBm



Modified Un-Modified

Interference -15dBm Psat=-130dBm

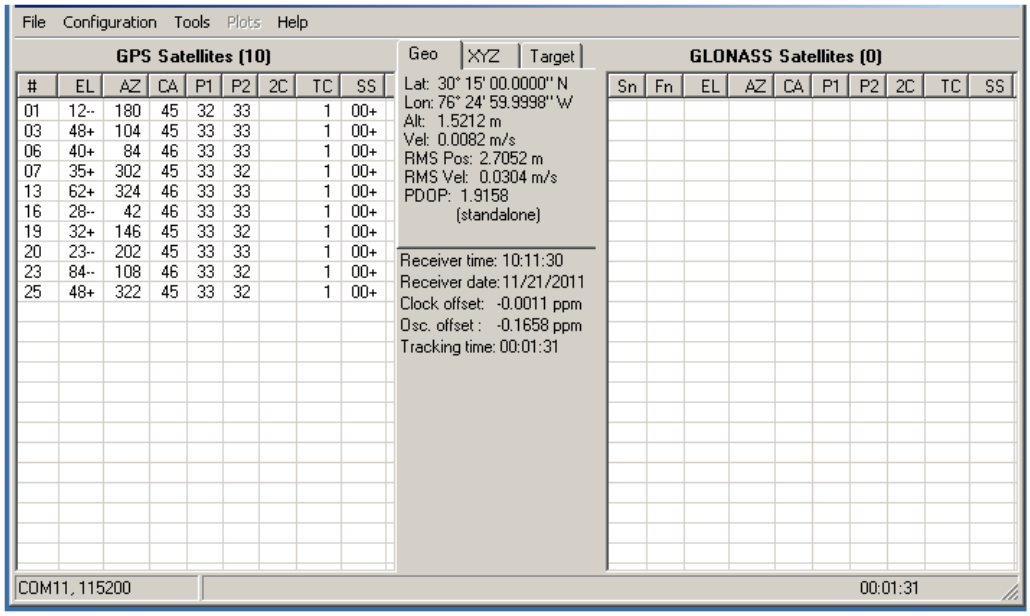


Modified Un-Modified

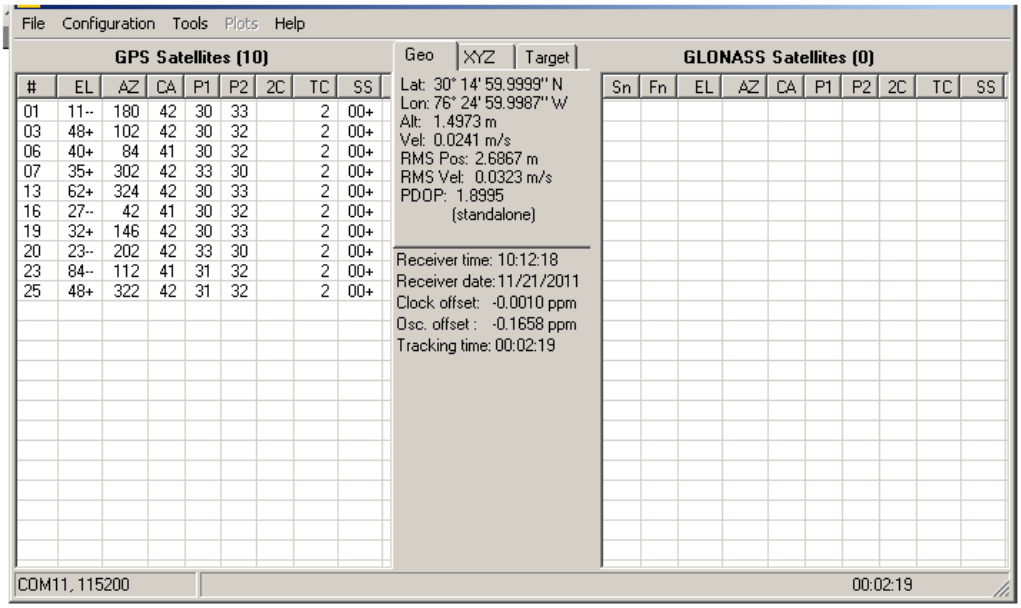
17169 Sensitivity Testing

1. Unmodified Antenna 12867 – with no interference

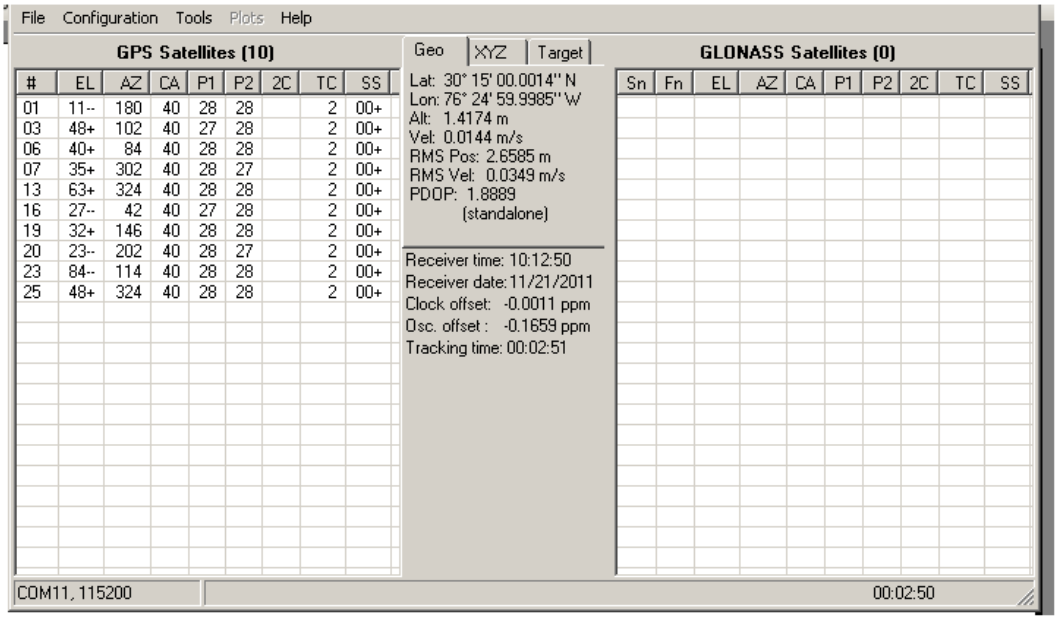
No Interference, Psat = -130 dBm



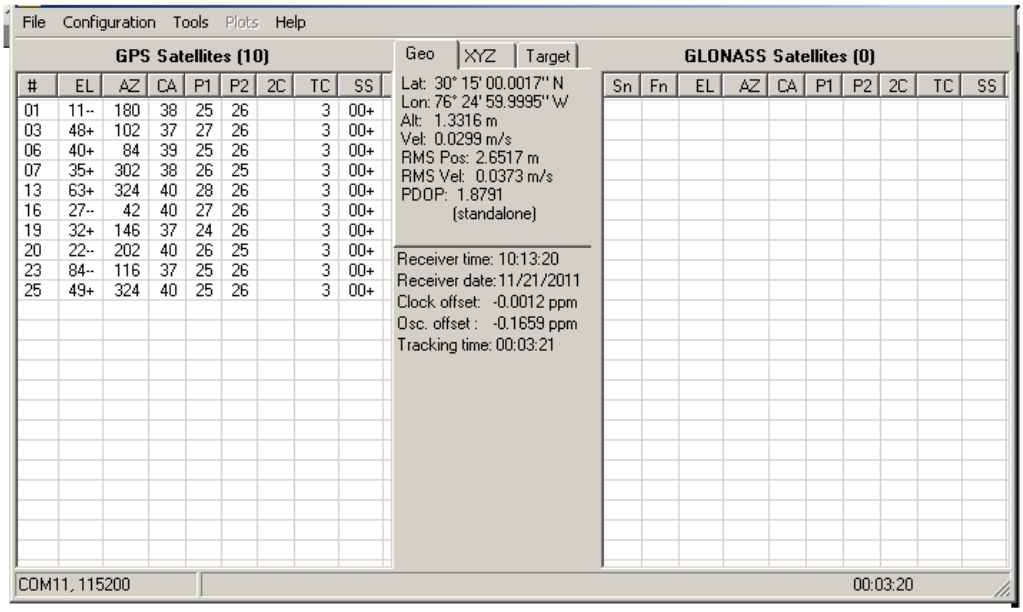
No Interference, Psat = -135 dBm



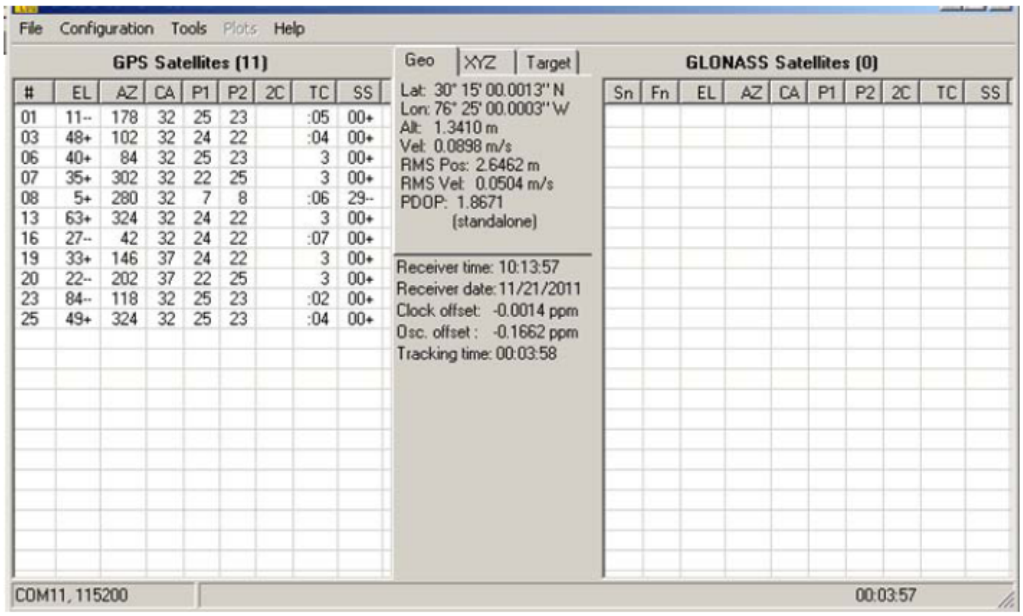
No Interference, Psat = -137 dBm



No Interference, Psat = -140 dBm

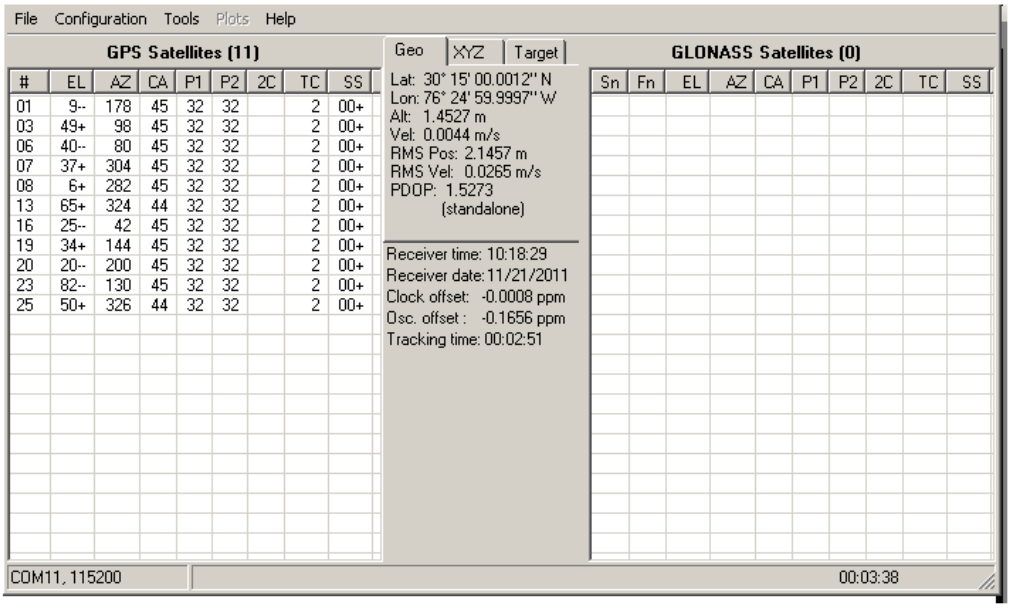


No Interference, Psat = -145 dBm

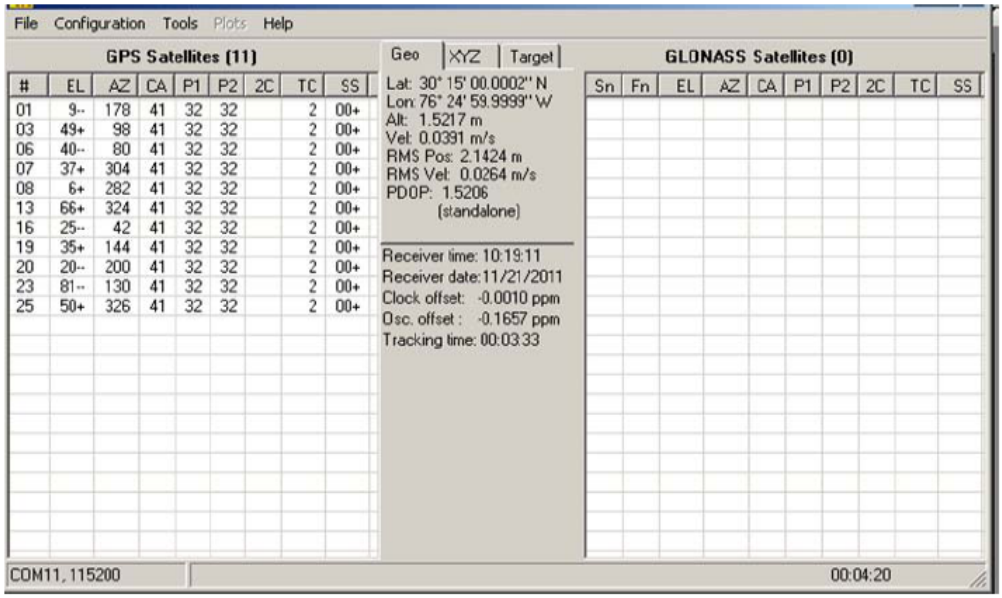


2. Unmodified Antenna 12867 with interference

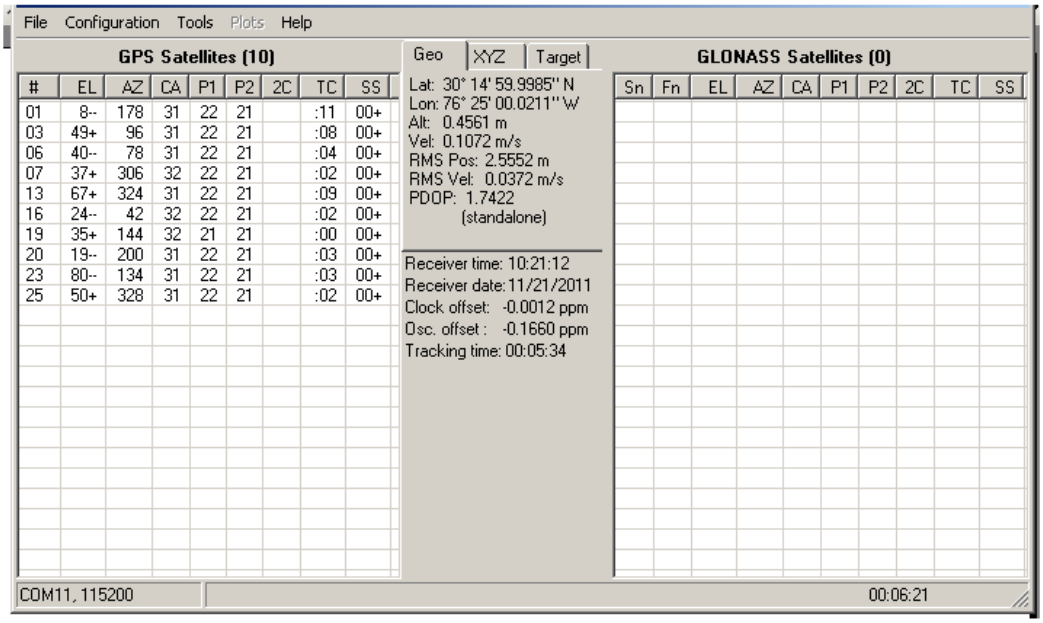
Interference -30 dBm @ device, Psat = -130 dBm



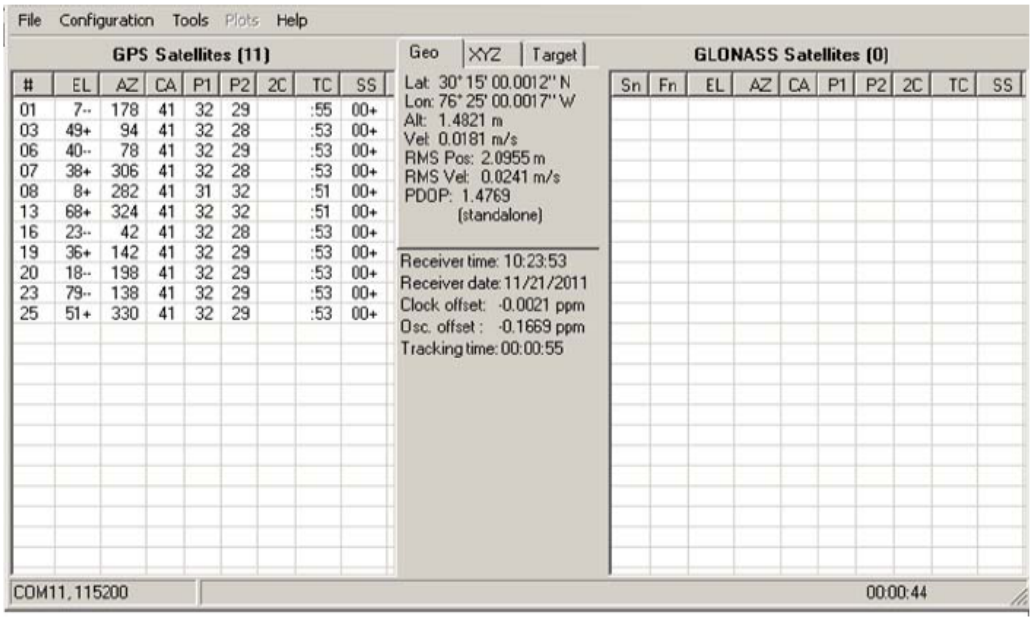
Interference -30dBm @ device, Psat = -135 dBm



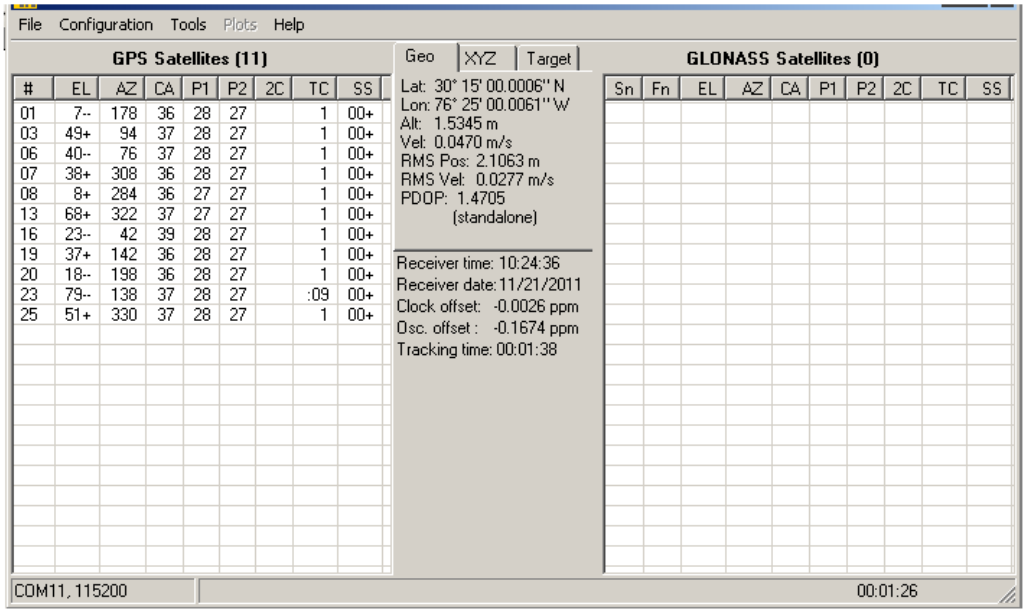
Interference -30dBm @ device, Psat = -145 dBm



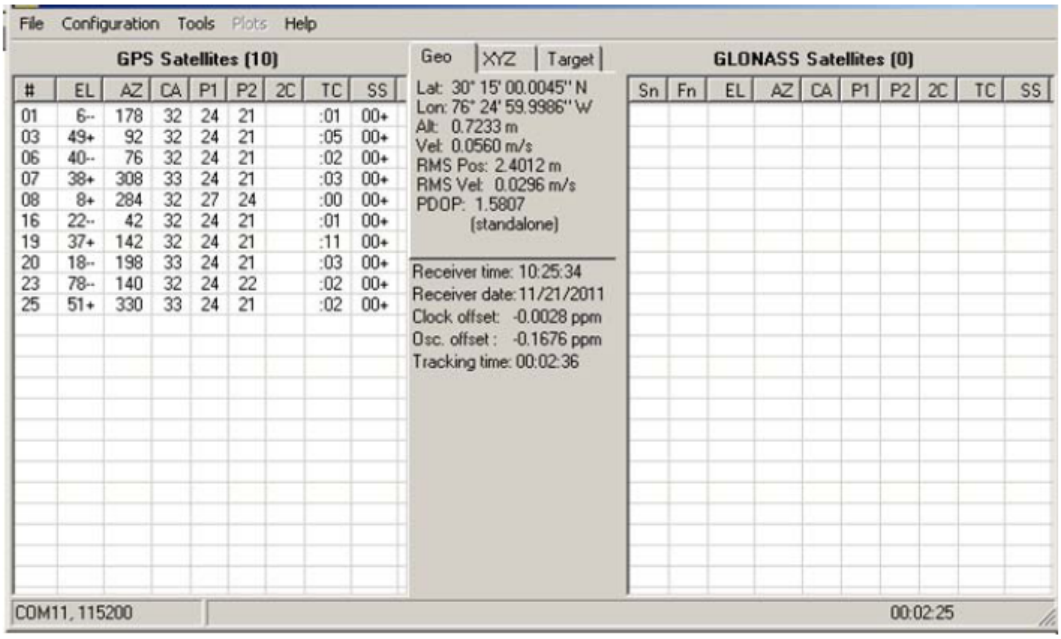
Interference -24dBm @ device, Psat = -130 dBm



Interference -24dBm @ device, Psat = -135 dBm

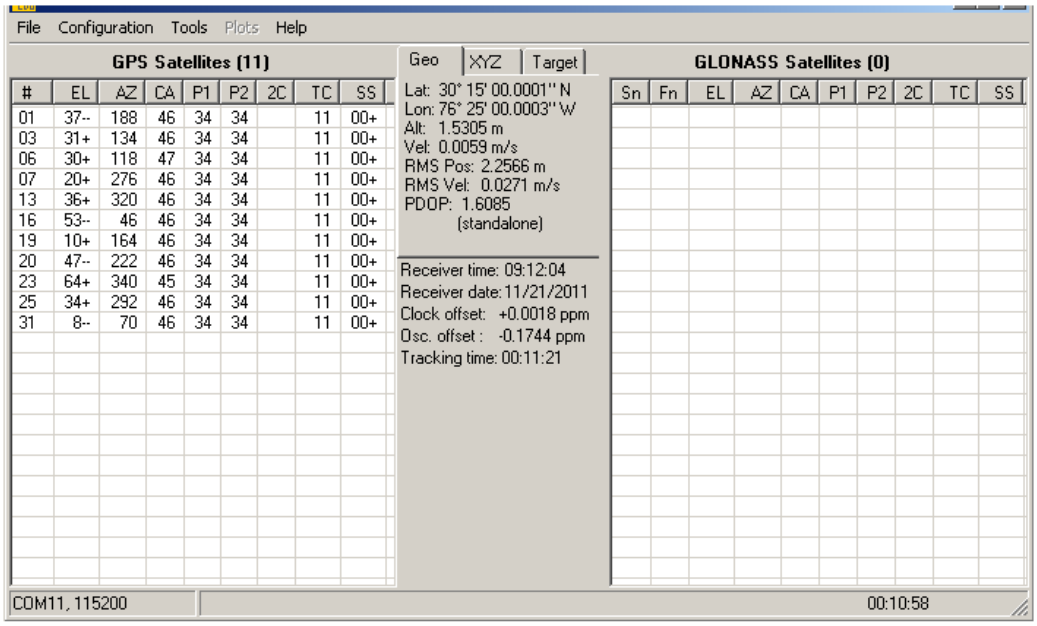


Interference -24dBm @ device, Psat = -140 dBm

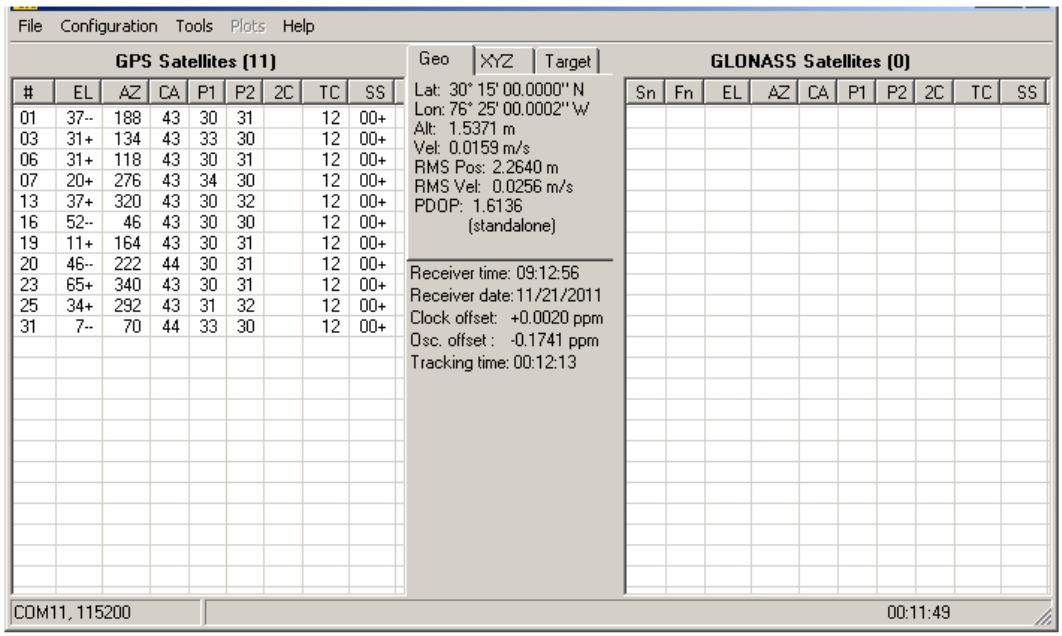


3. Modified Antenna with no interference

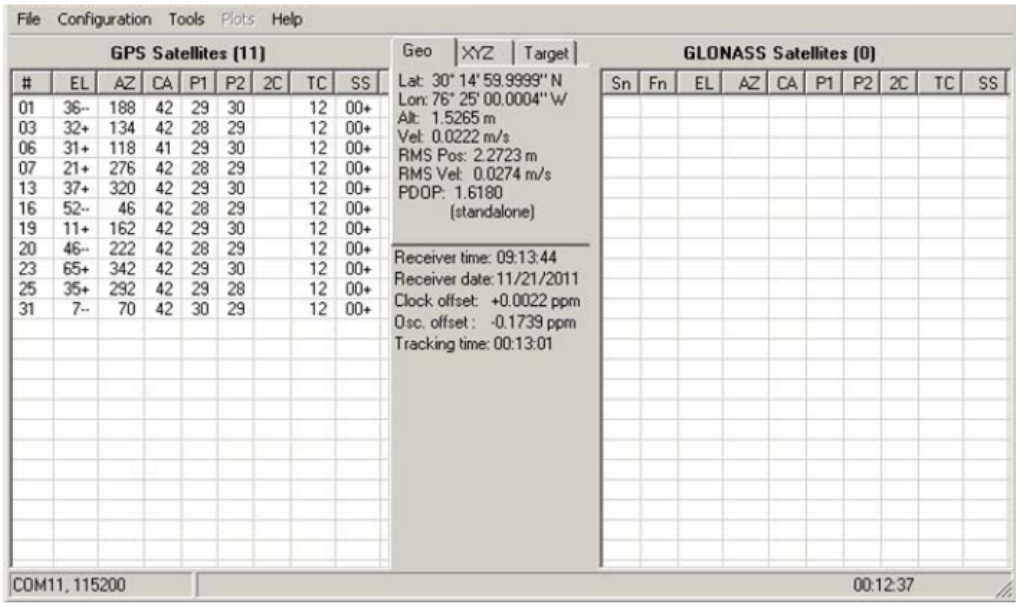
No Interference, Psat = -130 dBm



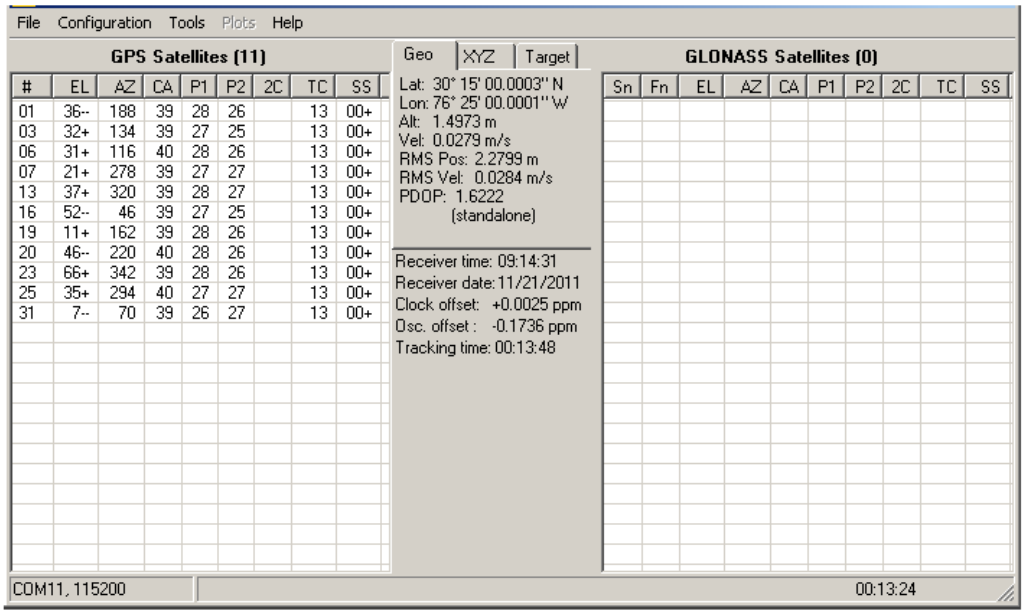
No Interference, Psat = -135 dBm



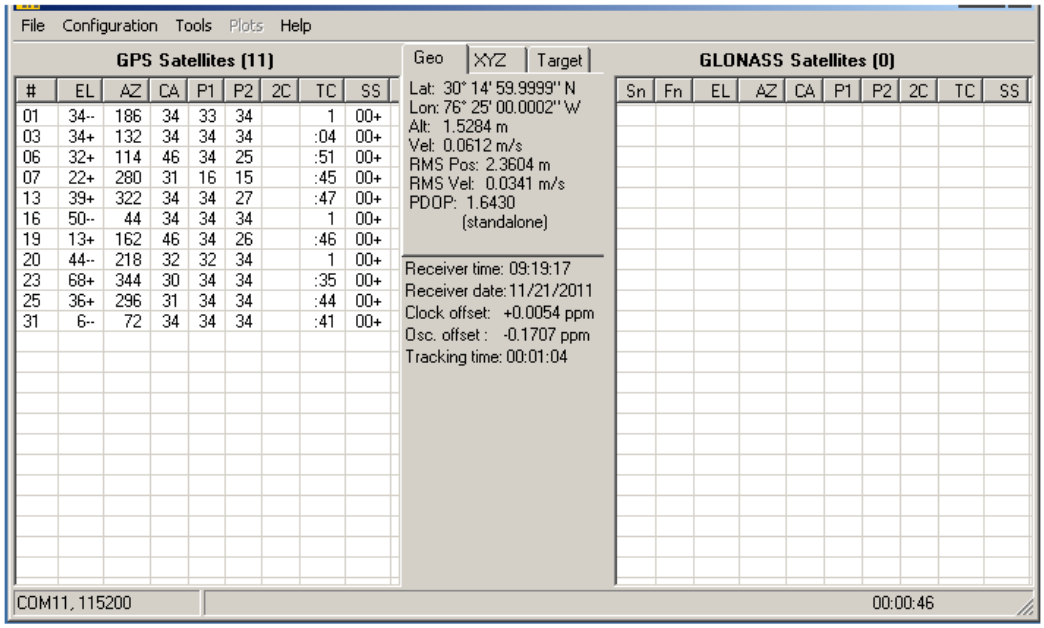
No Interference, Psat = -137 dBm



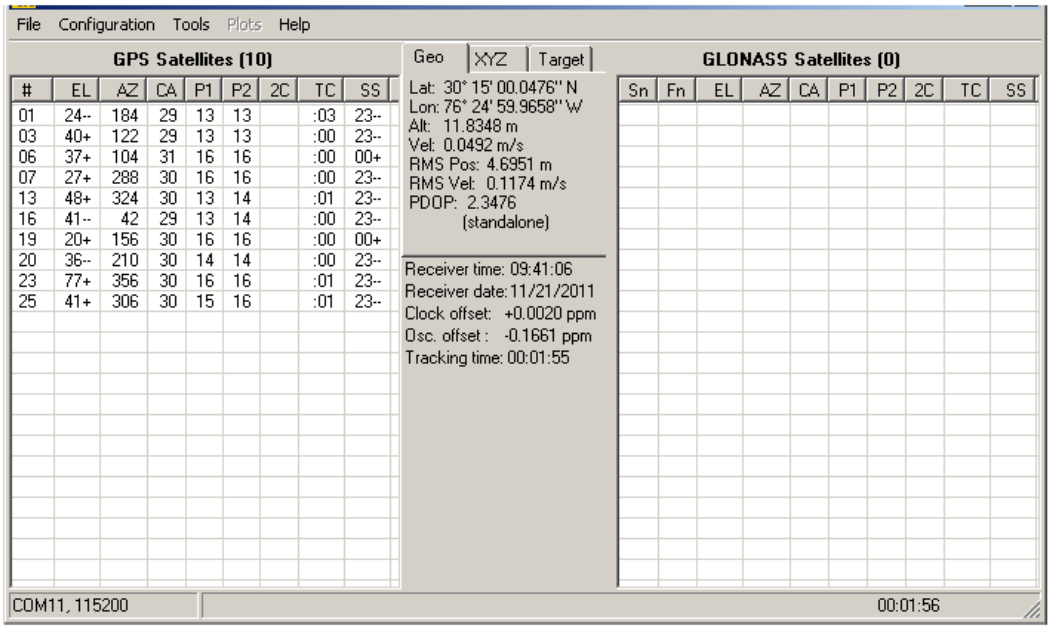
No Interference, Psat = -140 dBm



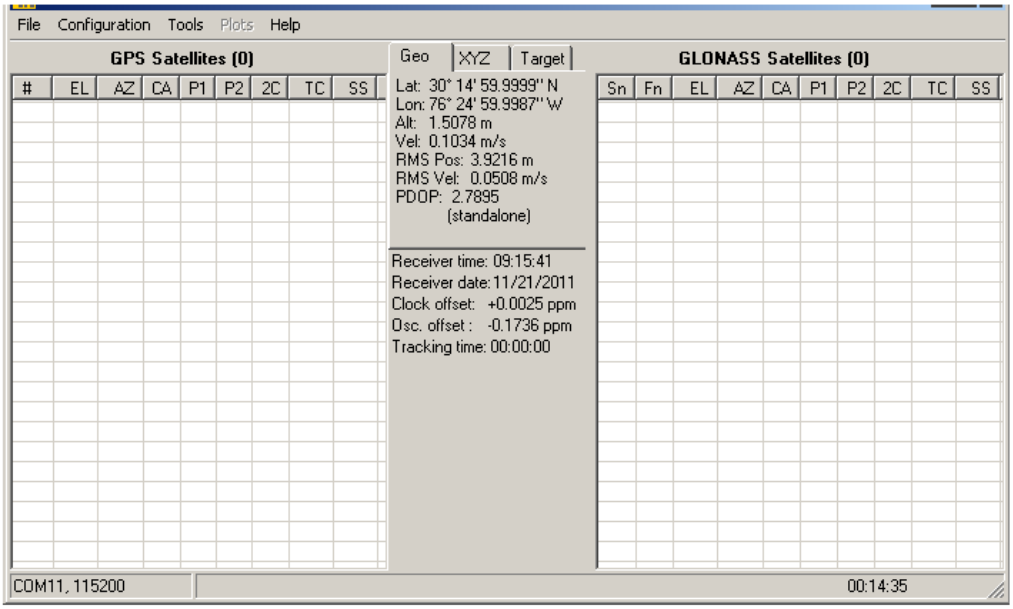
No Interference, Psat = -145 dBm



No Interference, Psat = -150 dBm

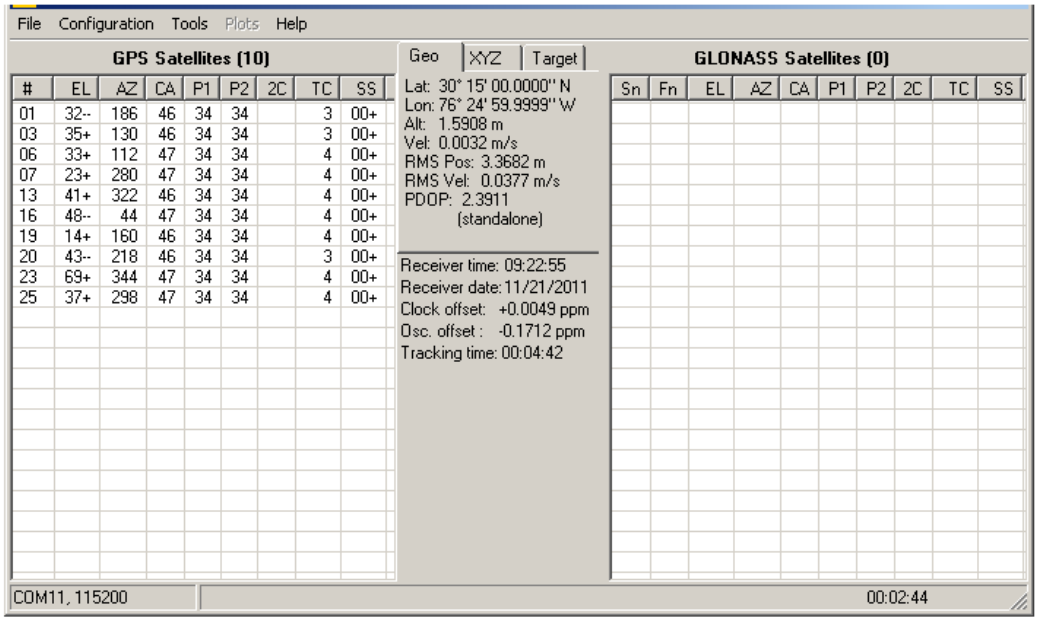


No Interference, Psat = -155 dBm

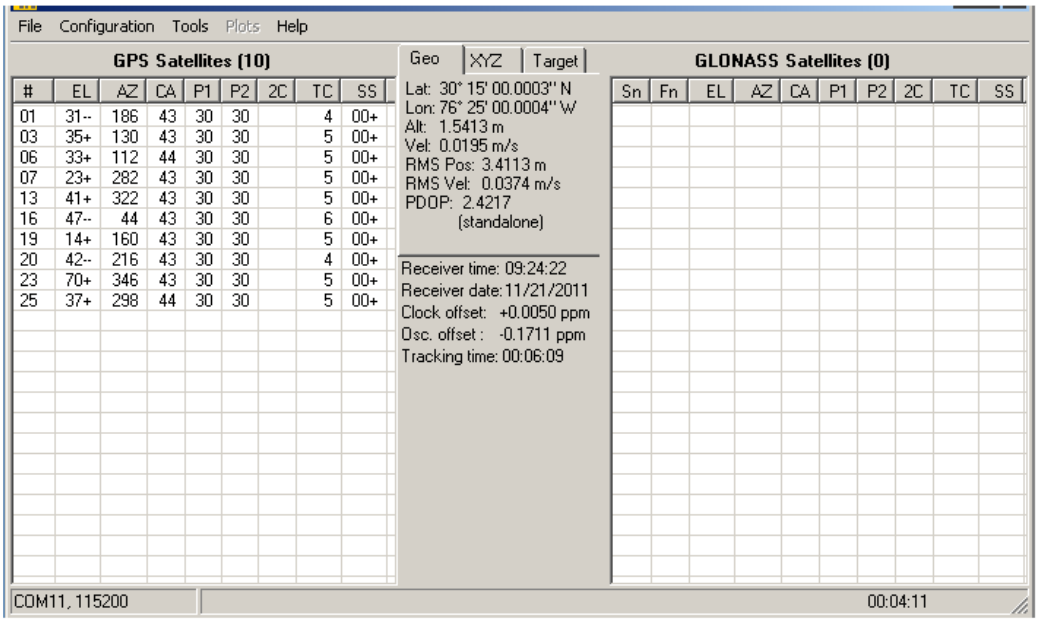


4. Modified Antenna with interference

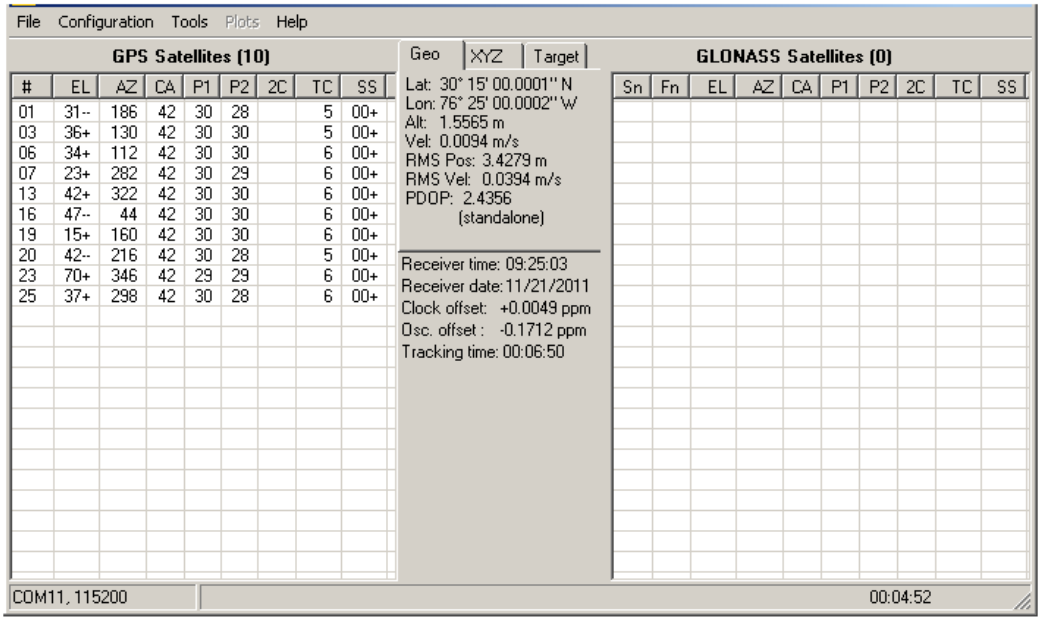
Interference -30 dBm @ device, Psat = -130 dBm



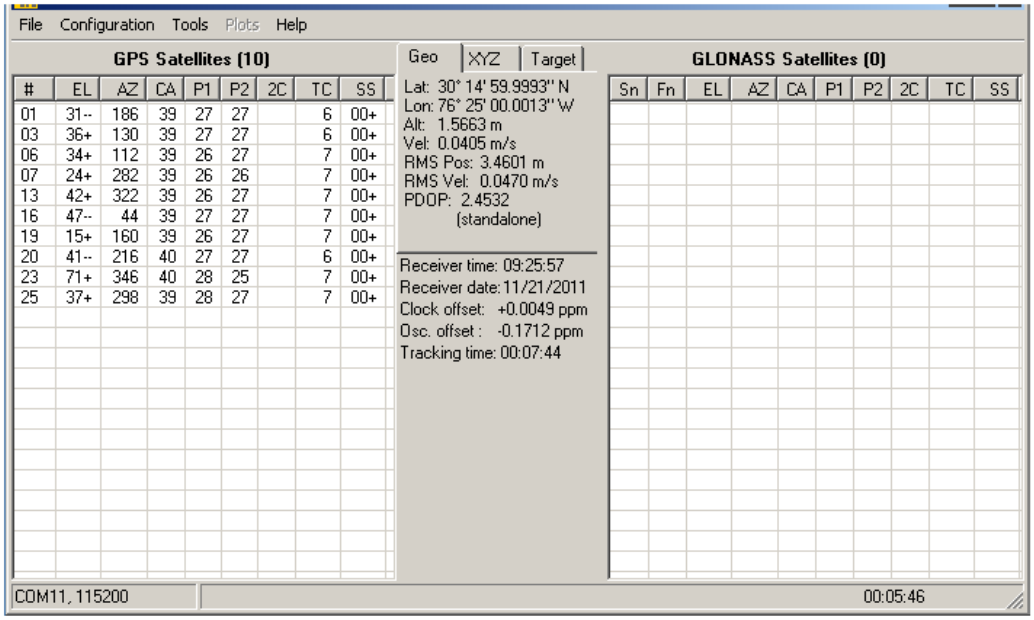
Interference -30dBm @ device, Psat = -135 dBm



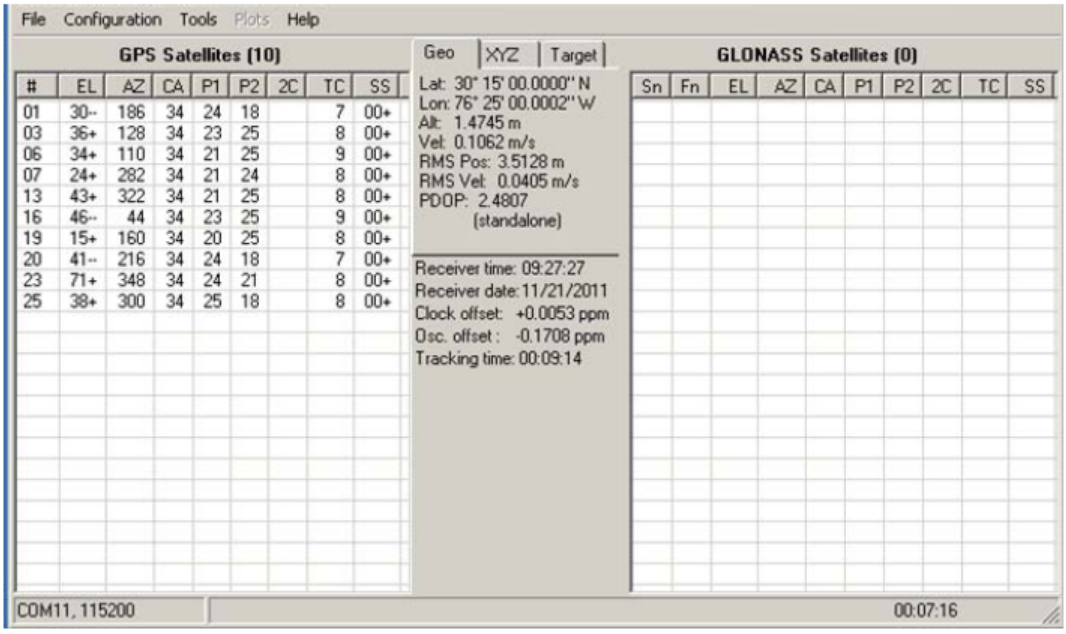
Interference -30dBm @ device, Psat = -137 dBm



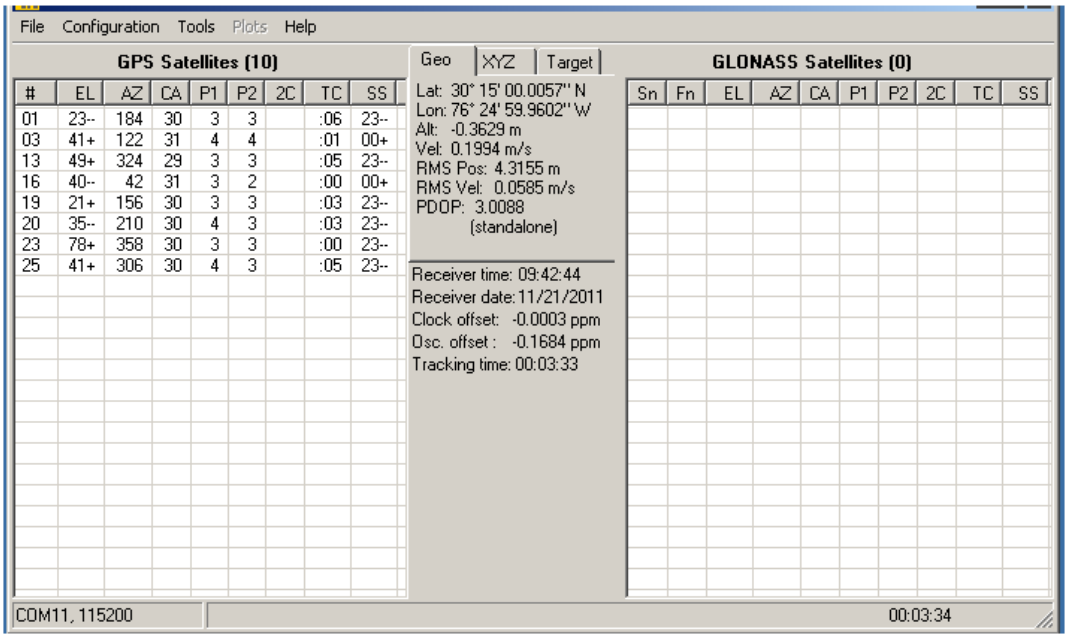
Interference -30dBm @ device, Psat = -140 dBm



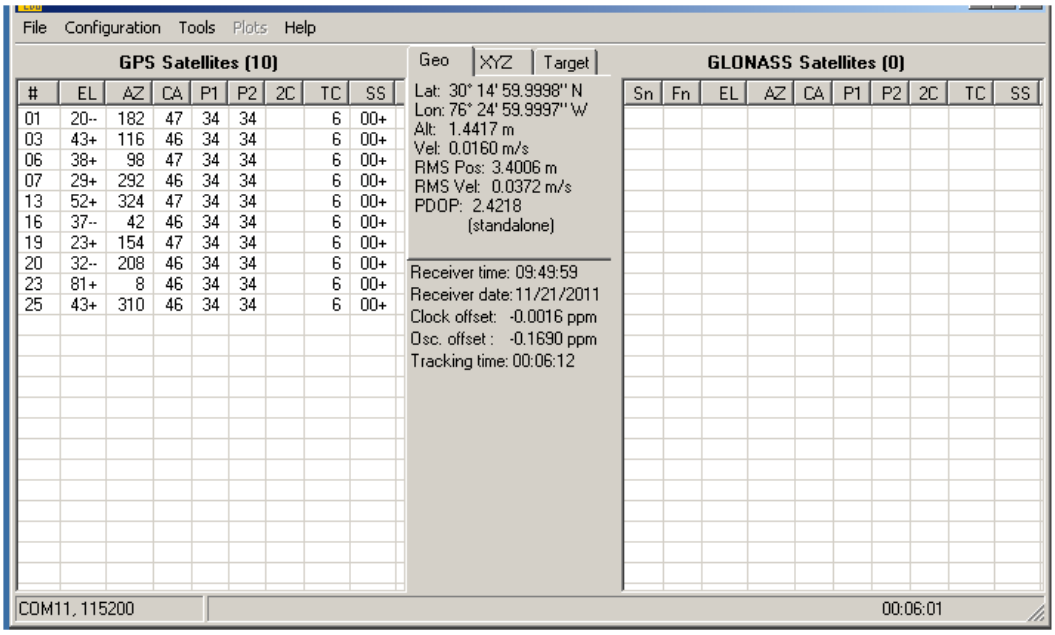
Interference -30dBm @ device, Psat = -145 dBm



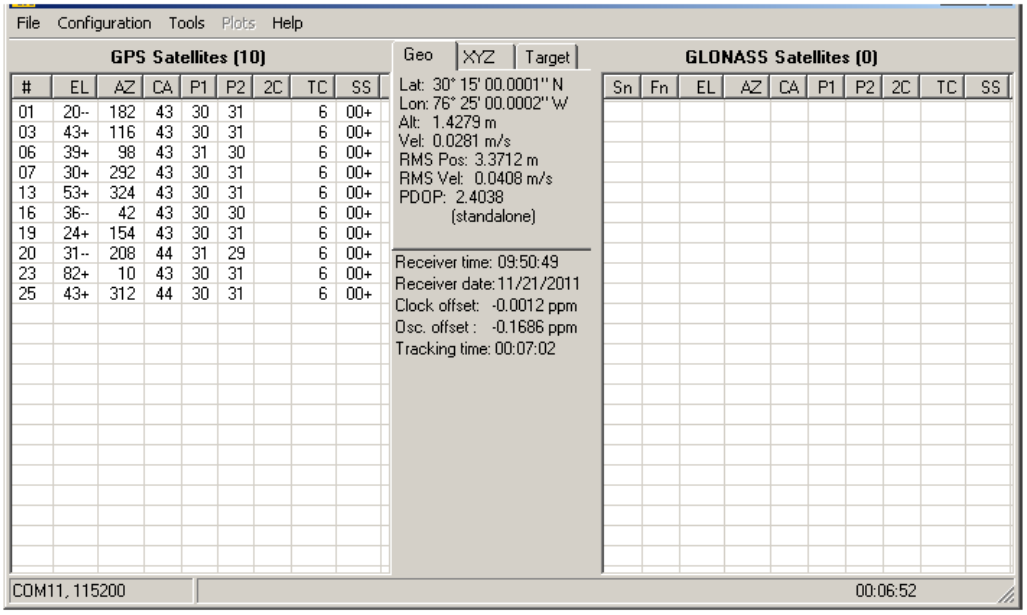
Interference -30dBm @ device, Psat = -150 dBm



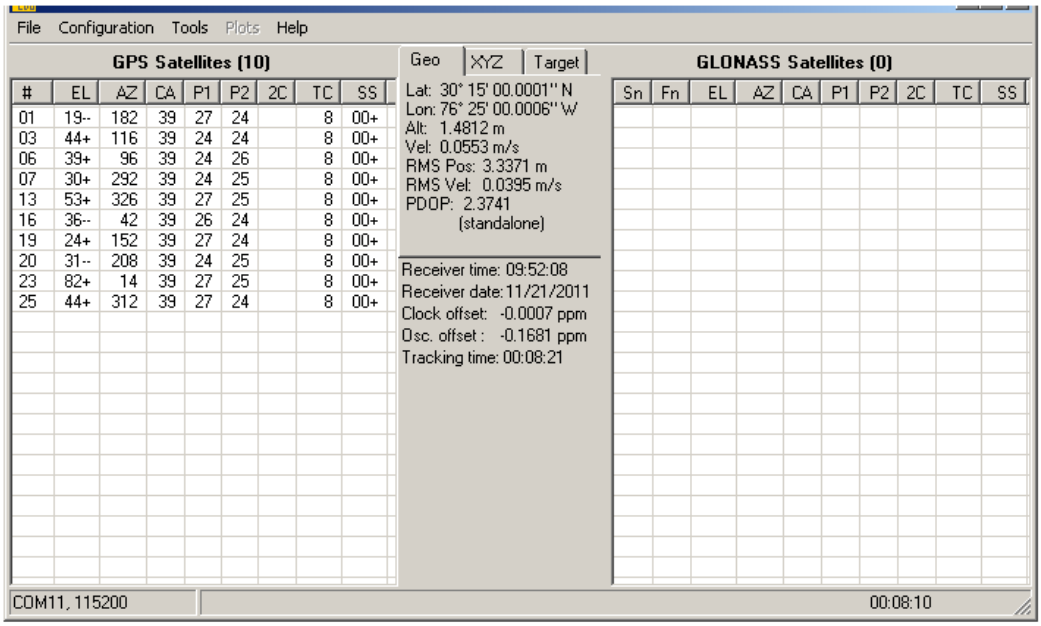
Interference -24dBm @ device, Psat = -130 dBm



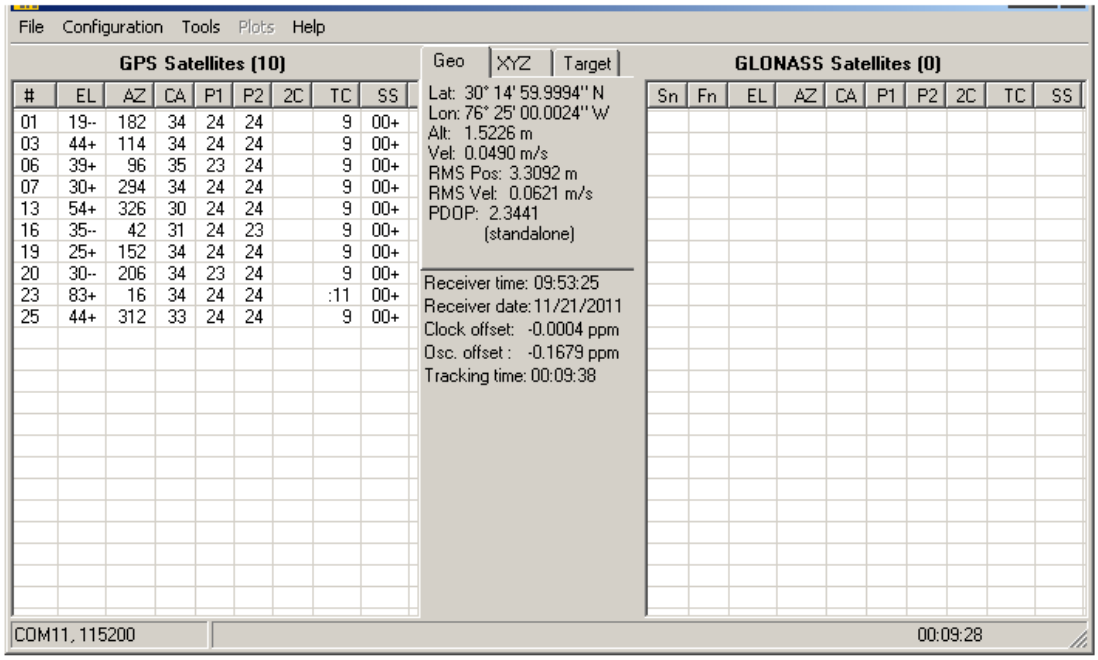
Interference -24dBm @ device, Psat = -135 dBm



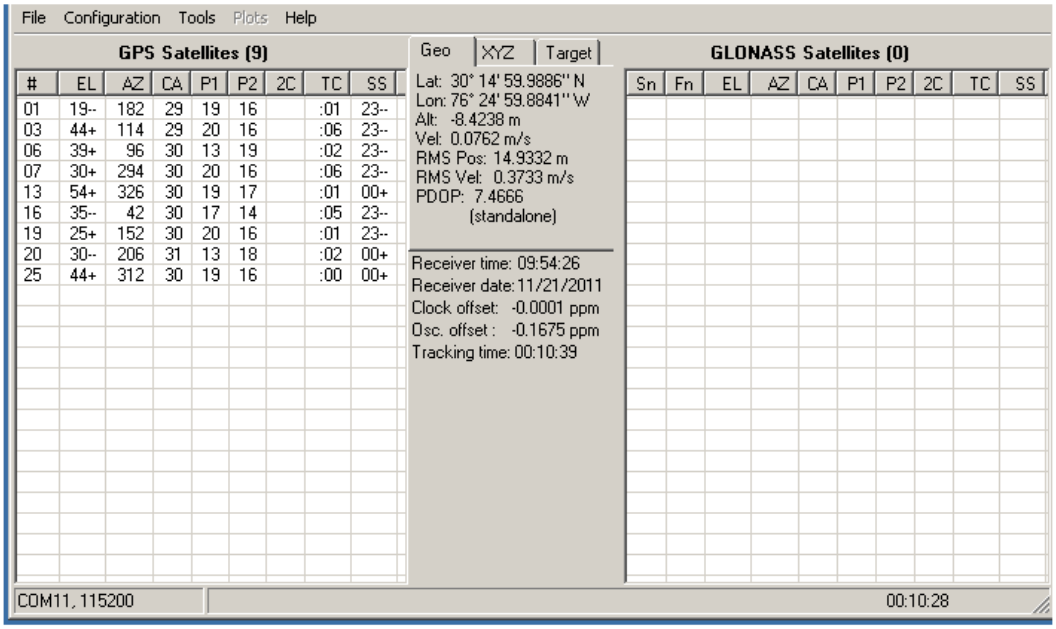
Interference -24dBm @ device, Psat = -140 dBm



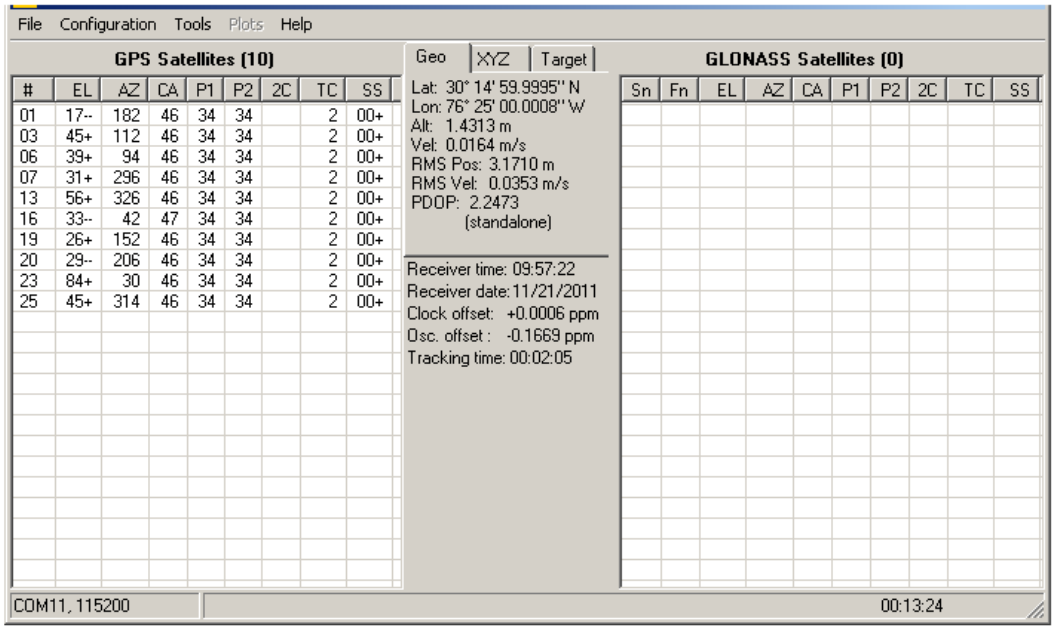
Interference -24dBm @ device, Psat = -145 dBm



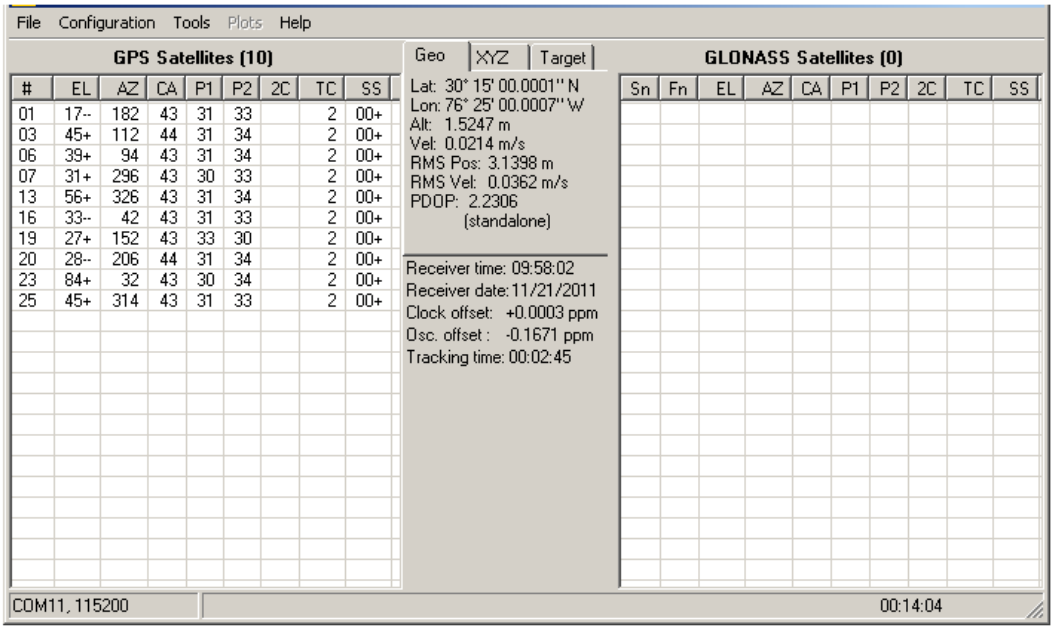
Interference -24dBm @ device, Psat = -150 dBm



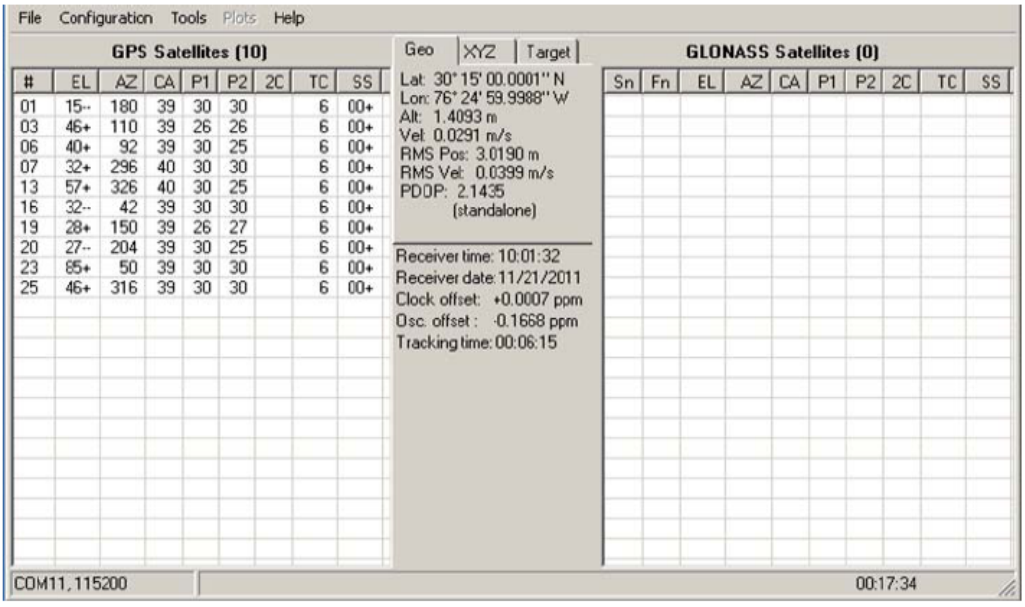
Interference -15dBm @ device Psat=-130dBm



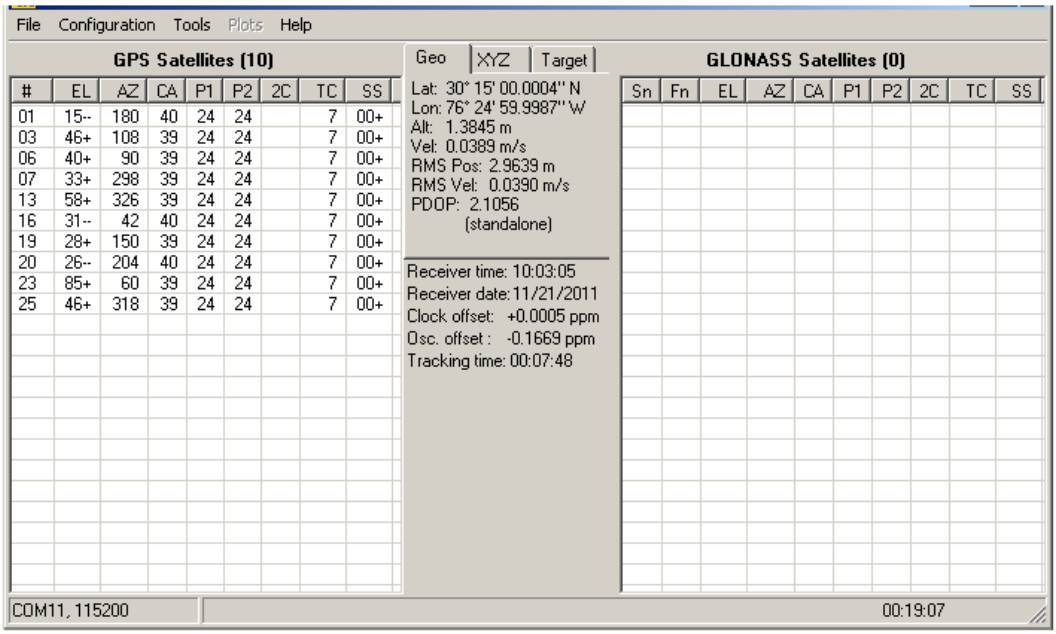
Interference -15dBm @ device Psat=-135 dBm



Interference -15dBm @ device Psat=-140dBm



Interference -15dBm @ device Psat=-145dBm



Interference -15dBm @ device Psat=-150dBm